Approved 8-13-98

Responses of River Otters to Oil Contamination: A Controlled Study of Biological Stress Markers

Project Number:	99348
Restoration Category:	Research
Proposer:	M. Ben-David, T. Bowyer, L. Duffy/UAF
Lead Trustee Agency:	ADFG
Cooperating Agencies:	None
Alaska SeaLife Center:	Yes
New or Continued:	Cont'd
Duration:	2nd yr. 2 yr. project
Cost FY 99:	$240.1
Cost FY 2000:	$0.0
Cost FY 01:	$0.0
Cost FY 02:	$0.0
Geographic Area:	Prince William Sound, Seward
Injured Resource/Service:	River otter

ABSTRACT

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

INTRODUCTION

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

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

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

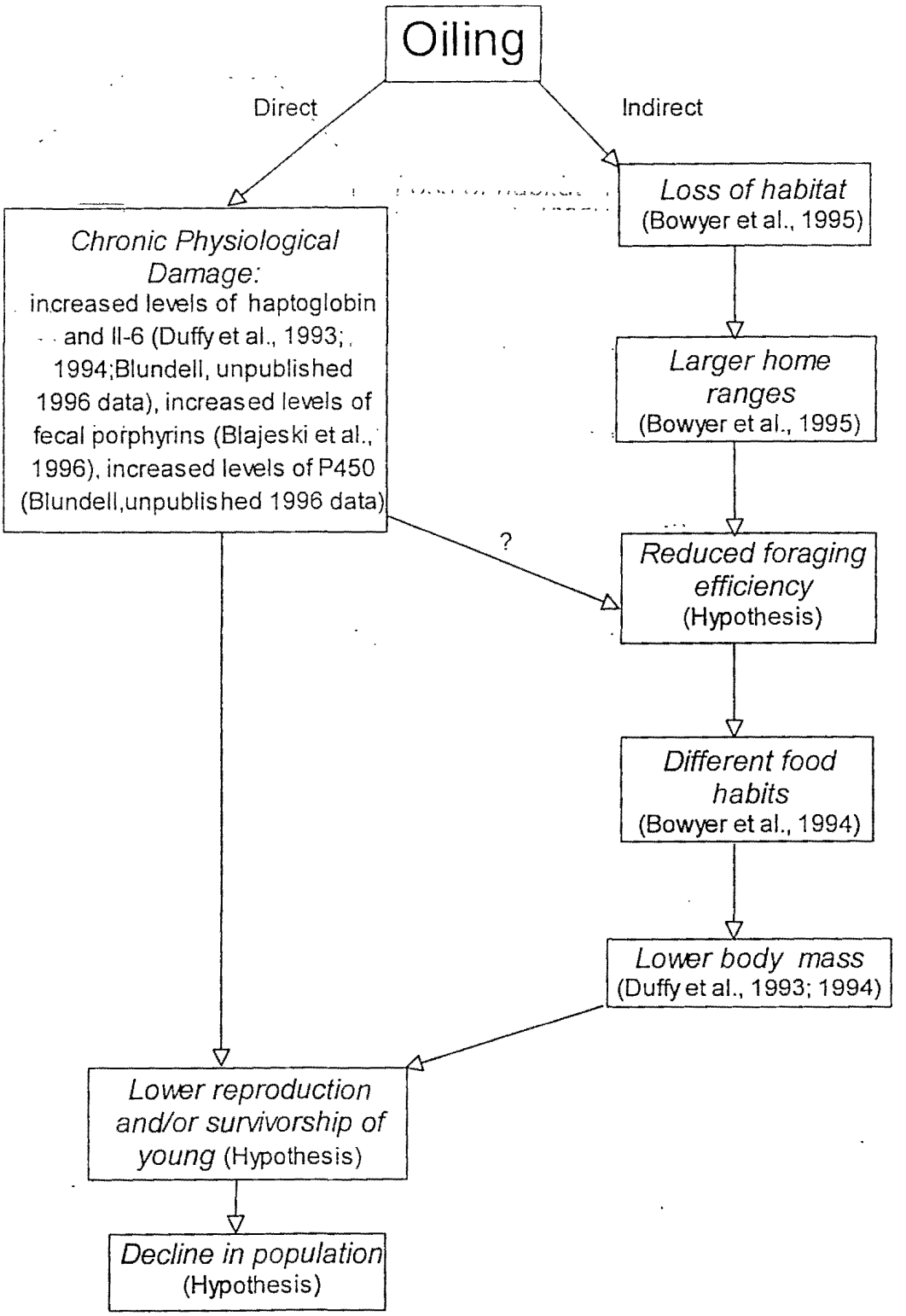

Fig. 1 - Possible pathways for the effect of oiling on river otters in Prince William Sound, Alaska

Background

General

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

Biomarkers

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

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

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

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

NEED FOR THE PROJECT

A. Statement of Problem

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

B. Rationale/Link to Restoration

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

C. Location

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

COMMUNITY INVOLVEMENT

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

PROJECT DESIGN

A. Objectives

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

B. Methods

General

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

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

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

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

Serum obtained from the 15 river otters live-captured in PWS will be sent for screening of the following diseases:

1. Aleutian disease
2. canine distemper
3. phocid distemper

This initial screening will assist in determining whether the trapped animals have been previously exposed to these diseases prior to their placement in captivity. Although rarely observed in free-ranging mustelids, these three diseases are the most likely diseases to be contracted by these carnivores.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Tissue sampling

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

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

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

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

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

Assays Biological Stress Markers and Immunology

Haptoglobins

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

Interleukin - 6

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

Cytochrome P450 assays

Two approaches will be taken to evaluate cytochrome P450 levels:

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

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

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

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

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

Hematology and serum chemistry

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

Immune function assays

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

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

Assays of Fecal Porphyrins

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

Oil Measurement in Feces

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

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

Fecal Extraction

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

Diode-array Spectrophotometry

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

HPLC Analysis

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

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

Statistical Analysis

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

C. Cooperating Agencies, Contracts, and Other Agency Assistance

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

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

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

SCHEDULE

A. Measurable tasks for FY98 and FY99

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

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

B. Project milestones and endpoints

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

C. Completion Date

The work will be completed by Sept. 1999.

PUBLICATIONS AND REPORTS

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

PROFESSIONAL CONFERENCES

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

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

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

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

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

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

PRINCIPAL INVESTIGATORS

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

Dr. R. Terry Bowyer
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ffrtb@aurora.alaska.edu

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

Dr. Lawrence K. Duffy
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University of Alaska
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fychem@acad3.alaska.edu

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

Revisio 12-14-98
FINA_ BUDGET

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

Budget Category:	Authorized FY 1998	Proposed FY 1999						
Personnel		$0.0						
Travel		$0.0						
Contractual		$224.4						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$224.4		Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
General Administration		$15.7						
Project Total	$0.0	$240.1						
Full-time Equivalents (FTE)		0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY 99

Project Number: 99348
Project Title: Responses of river otters to oil contamination: a controlled study of biological stress markers
Agency: ADF&G

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: 3/25/98
Revised: 7/7/98, 8.26.98, JRS 14 Oct 98; wjh

FY 99 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1999
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.0	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1999
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY 99

Prepared: 3/25/98
Revised: 7/7/98, 8.26.98, JRS

Project Number: 99348
Project Title: Responses of river otters to oil contamination: a controlled study of biological stress markers
Agency: ADF&G

FORM 3B
Personnel
& Travel
DETAIL

FY 99 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Contractual Costs:	Proposed FY 1999
Description	
RSA with UAF	193.8
Alaska SeaLife Center bench fees	30.6
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$224.4

Commodities Costs:	Proposed FY 1999
Description	
Commodities Total	$0.0

FY 99

Project Number: 99348
Project Title: Responses of river otters to oil contamination: a controlled study of biological stress markers
Agency: ADF&G

FORM 3B
Contractual & Commodities DETAIL

Prepared: 3/25/98
Revised: 7/7/98, 8.26.98, JRS

FY 99 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

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

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

FY 99

Project Number: 99348
Project Title: Responses of river otters to oil contamination: a controlled study of biological stress markers
Agency: ADF&G

FORM 3B
Equipment
DETAIL

Prepared: 3/25/98
Revised: 7/7/98, 8.26.98, JRS

FY 99 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel	$63.9	$71.0
Travel	$15.1	$10.7
Contractual	$62.8	$64.2
Commodities	$8.7	$10.8
Equipment	$0.0	$0.0
Subtotal	$150.5	$156.7
Indirect	$37.6	$37.10
Project Total	$188.1	$193.8
Full-time Equivalents (FTE)	16.5	16.3
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

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

Dollar amounts are shown in thousands of dollars.

Comments:

1. Indirect costs at 25% as agreed with the University of Alaska Fairbanks. For contractual work with another institution at cost between 25,000 and 250,000 (Purdue University) indirect cost at 5%. (This comment is no longer valid; WJH, 14 Oct 98)
2. 3% of direct cost will be spent on community Involvement.
3. 3% of direct cost will be spent on attending workshops and professional meetings.
4. Bench fees for housing otters in the Sealife Center will be negotiated directly between Trustees council and Sealife cooredinator.
5. Travel from lower 48 for Dr. Lyman McDonald to attend restoration meeting and discuss data analysis. Travel from Europe for Dr. Hans Kruuk for consultation on release of animals.
6. Three additional transmitters are available from NVP.

NOTE: The line-item distribution for this budget has been adjusted to reflect a lowered cost for a sub-contract and lowered cost for Personnel (Ben-David) so the Indirect Cost for the UAF could be increased. (14 Oct 98, WJH)

FY 99

Project Number: 99348
Project Title: Responses of river otters to oil contamination: a controlled study of biological stress markers
Name: Institute of Arctic Biology - UAF

FORM 4A
Non-Trustee
SUMMARY

Prepared: 3/25/98
Revised: 7/7/98, 8.26.98, JRS

FY 99 EXXON VALDEZ TRU! COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 1999
	M. Ben-David	Principle Investigator - coordinator	8.7	4.5		39.2
	R. T. Bowyer	Principle Investigator - analysis and reprot	0.0	10.5		0.0
	L. K. Duffy	Principle Investigator - lab analyses	0.8	10.6		8.5
	O. Ormseth	Technician - data collection and animal ca	5.0	2.2		11.0
	A. Porchet	Technician - lab analyses	1.8	6.7		12.1
						0.0
						0.0
						0.0
		Adjustment for rounding				0.2
						0.0
						0.0
						0.0
		Subtotal	16.3	34.5	0.0	
					Personnel Total	$71.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 1999
	Travel to Fairbanks from lower 48	0.8	1	4	0.1	1.2
	Travel to fairbanks from Europe	2.0	1	3	0.1	2.3
	Travel to Seward	0.1	4	20	0.1	2.4
	Travel to Anchorage	0.2	2	6	0.2	1.6
	Travel to professional meetings	0.8	2	8	0.2	3.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$10.7

FY 99

Project Number: 99348
Project Title: Responses of river otters to oil contamination: a controlled study of biological stress markers
Name: Institute of Arctic Biology - UAF

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 3/25/98
Revised: 7/7/98, 8.26.98, JRS

FY 99 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Contractual Costs:	Proposed
Description	FY 1999
Statistical consultation	4.0
P450 - Woodshole @ 110.0 per sample 75 samples	8.3
Purdue (RT-PCR for P450, serum protein electrophorysis, lymphocyte transformation, Ig quant.) @ 260.0 per sample x 150 sample	35.1
Quest lab (CBC and full blood panel) @ 38.0 per sample x 150 samples	5.7
Disease screening (admission to ASLC, Aleutien, phocid and canine distemper) @ 55.0 per sample x 30 samples	1.7
Charter plane for release @ 600.0 x 6 flights	3.6
Telemetry flights after release @ 300.0 x 6 flights	1.8
Publication costs	4.0
Contractual Total	$64.2

Commodities Costs:	Proposed
Description	FY 1999
Haptoglobin 8 kits (150 samples) @ 165.0 per kit	1.3
Interleukin-6 8 kits (150 samples) @ 550.0 per kit	4.4
Lab supplies for fecal porphyrins	1.5
Radiotransmitters @ 300.0 x 12 units	3.6
Commodities Total	$10.8

FY 99

Project Number: 99348
Project Title: Responses of river otters to oil contamination: a controlled study of biological stress markers
Name: Institute of Arctic Biology - UAF

FORM 4B
Contractual & Commodities DETAIL

Prepared: 3/25/98
Revised: 7/7/98, 8.26.98, JRS

FY 99 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

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

Existing Equipment Usage:	Number
Description	of Units
HPLC analyzer	1
Telonics receivers	2
GPS unit	2
Computer	2
Radiotransmitters	3

FY 99

Project Number: 99348
Project Title: Responses of river otters to oil contamination: a controlled study of biological stress markers
Name: Institute of Arctic Biology - UAF

FORM 4B
Equipment
DETAIL

Prepared: 3/25/98
Revised: 7/7/98, 8.26.98, JRS

Revision 12-14-98
Approved TC 12-15-98

Dynamic Graphical Techniques for Ecosystem Synthesis and Knowledge Transfer (Submitted Under the BAA)

Project Number:	99361
Restoration Category:	Research and Monitoring (Ecosystem Synthesis)
Proposers:	Jennifer R. Allen and Robert T. Cooney
Lead Trustee Agency:	NOAA
Duration:	1 year
Cost FY 99:	$25,600
Cost FY 00:	$0
Cost FY 01:	$0
Geographic Area:	Spill-Affected Area

ABSTRACT

As the tenth anniversary of the *Exxon Valdez* oil spill (EVOS) approaches and restoration research efforts draw to a close, there is an increasing need for information synthesis, translation and communication. Useful transfer of ecosystem-level research results to the public, resource managers, policy makers and the wider scientific community remains a critical challenge. Project 99361 will augment existing synthesis efforts by focusing on graphical approaches, including advanced computer imaging and multimedia presentation technology. The utility of these technologies will be demonstrated by means of a high impact, dynamic, graphical presentation of the synthesized results of the SEA program. It is anticipated that techniques developed and refined during this work will have direct application to larger-scale synthesis, communication, and technology transfer tasks facing EVOSTC in the near future.

INTRODUCTION

Since 1994, the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) has recognized the need for multidisciplinary ecosystem-level investigations (EVOSTC, 1994) to increase understanding of system processes that may be constraining recovery of injured resources. Prominent among these have been the Sound Ecosystem Assessment (SEA), Nearshore Vertebrate Predator (NVP) and Alaska Predator Ecosystem Experiment (APEX) programs. As the tenth anniversary of the oil spill approaches and the restoration phase research efforts are drawing to a close, several pressing needs are apparent:

1. Information synthesis within and between projects;
2. Translation and communication of results to non-specialist stakeholders; and
3. Transfer of useable knowledge and products to mangers and decision makers.

These three tasks: synthesis, communication, and technology transfer, are interrelated. Communication of synthesized findings in understandable form is fundamental to successful knowledge transfer and application. All three tasks were recognized by the Interagency Ecosystem Management Task Force as critical to implementation of ecosystem approaches in resource management. The report of that task force included specific recommendations to: (a) direct funding into overview and translation activities, including comprehensive syntheses; and (b) establish and recognize as important the position/function of information specialist or scientific translator, to provide a key bridge between scientists, managers and the public (IEMTF, 1995).

Graphical display techniques provide a powerful communication tool which takes advantage of the potent information processing and comprehension abilities of the human visual system (Gershon, 1994). Use of graphics technology enables "high bandwidth" information transfer and enhanced comprehension. In most cases, visual representation has been found to be more intuitive or accessible than numerical or mathematical portrayals of the same data (Arrott, 1992). Further, the ability to visualize complex datasets, models and results from simulations is increasingly regarded as essential in provoking insights and enabling communication (Kaufman, 1994) through illustration of concepts and complex relationships.

In the last several years, exponentially increasing computer processing speed and video handling capabilities, plus increasingly sophisticated mid-range software for graphics and video editing, have brought to the desktop power that was previously only accessible at great expense in professional production studios. Digital audio and video capabilities now enable integrated multimedia delivery of information (text, graphics, images, animations, audio, video). This addition of time-based media (motion and sound) to conventional forms of static graphical delivery has opened up new communications possibilities, such as progressive visual unfolding of information and exploration of changes that occur over time. Presentation of information via multiple modalities including visuals, sound, motion and interactivity has been shown to improve retention rates, learning speed, attention levels, credibility and overall impact of presentations (Lindstrom, 1994).

The intent of the work proposed here is to augment existing EVOSTC synthesis efforts by focusing on dynamic graphical approaches, including advanced computer imaging and multimedia presentation technology. The utility of these technologies will be explored and demonstrated by means of an example: a high impact, dynamic, graphical presentation of the synthesized results of the 5-year SEA investigation. The challenging requirements of the presentation are: (1) to communicate integrated multidisciplinary conclusions about ecosystem processes and the complex physical-biological interactions which jointly influence pink salmon and herring production in Prince William Sound; (2) to explain the workings and results of SEA's numerical models which describe these processes; and (3) to present the explanation in an appealing, understandable and useful format for a non-specialist audience.

It is anticipated that techniques developed and refined during this work will have direct application to larger-scale synthesis, communication, and technology transfer tasks facing the EVOSTC in the near future.

NEED FOR THE PROJECT

A. Statement of the Problem

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

In order for the goals and value of EVOSTC-funded restoration research to be fully realized, it is important that new knowledge and its implications be disseminated to the public, managers, decision makers and the scientific community. This knowledge transfer is a critical step in providing a more informed basis for restoration activities, management, and design of future long-term monitoring plans. The specific presentation proposed here will assist in communicating complex new understanding regarding ecosystem controls on production of two injured species: pink salmon and Pacific herring.

B. Rationale/Link to Restoration

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

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

C. Location

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

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

COMMUNITY INVOLVEMENT

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

Affected communities will be informed of the project and may provide input via a dedicated web site created and maintained by Dr. Allen. A major purpose of this work is to serve communities in the spill affected area by creating for the citizens a presentation of SEA research findings in understandable format. During 1998, the SEA presentation created for the January 98 Workshop was delivered by invitation to numerous community groups via a variety of forums. We expect to make similar community presentations of the currently proposed production during 1999. In addition, the production will be available for public distribution in video format.

PROJECT DESIGN

A. Objectives

The objectives of this project are:

1. To illustrate EVOSTC achievements in ecosystem research via a high impact graphical presentation covering the final synthesis of the SEA program. The presentation will be suitable for lay and general scientific audiences. It will be delivered live at the 10 Year Anniversary Symposium. An archived version will also be created on video format for wider distribution.*

2. To demonstrate a prototype use of graphically-based technologies that may have application to larger-scale synthesis and communication tasks facing the EVOSTC, as well as other sponsors of multi-disciplinary ecosystem studies, in the future.

* It should be noted that this objective goes beyond the scope of the work originally proposed for the SEA program. The work proposed here takes advantage of information delivery technology that was not available at the inception

of SEA and these tasks are not covered in the existing SEA budget.

B. Methods

General

EVOSTC achievements in ecosystem research will be illustrated via a high impact graphical presentation covering the final synthesis of the SEA program. The display will be similar in nature to our presentation at the January 98 Workshop. However it will extend the latter significantly, due to the greater degree of synthesis of results and the continuing expansion of technological capabilities which has occurred in the interim. Techniques used will draw heavily on images, video, targeted animations, simulations, and special effects, balanced with textual elements according to basic graphic design principles (Williams,1994; Priester,1995; Hooper,1997). The program will build the ecosystem story progressively, this time from a model-based perspective, adding detail one component at a time while maintaining sight of the larger picture, so that the audience is left with an appreciation not just of what was done but also of why it was done and what was learned. The presentation will be aimed at a level suitable for an informed lay audience but will contain sufficient depth to be of interest to the general scientific community.

The proposed work will be performed using advanced computer graphics techniques. High end authoring software will be used to produce an integrated multimedia presentation based on a timeline paradigm (Vaughan, 1998). Options for branching pathways, implemented by scripting in Lingo, will be exploited to yield two versions which differ in level of technical detail. Live delivery in March 1999 will be performed by an accomplished speaker, Dr. Cooney, supported by a computer-projected electronic show. A simplified version of the show will subsequently be transferred to videotape for wider distribution by EVOSTC. The videotape will target a general lay audience. This product will be designed to communicate a general understanding of key SEA concepts in an entertaining, informative and accessible format, for a wide public audience.

Steps in Production

1. Construction of the presentation storyboard . The presentation storyline will be developed with active participation of all SEA PI's, with oversight by the SEA Executive Committee
2. Assembly of core media components. Components include text, images, graphics, animations, model simulations, video clips, video background footage, sound clips.
3. Multimedia authoring. Sophisticated authoring software will be used to lay out the presentation using a timeline metaphor, and to sequence and overlay the components. A dedicated programming language (Lingo) will be used to impart specialized behaviors including branching timeline pathways and interactivity.
4. Editing and revisions of script, debugging of animation code. This step will include iterative consultations with the SEA group and will conclude after the group's approval of the final form of the production.
5. Assembly of additional video footage and script preparation for the analog video.

Consultation with staff at the EVOSTC Restoration Office will occur at at least two stages of production: early pre-review of storyboard and a more in-depth review of script, and possibly media clips, about midway through production. The lead investigator will work closely with the EVOSTC Restoration Office to help ensure that the video product effectively meets the needs of the target audience.

6. Output, delivery and archiving. The product of the authoring step will be exported in two several formats:

   (a) an executable binary for electronic delivery by projected presentation

   (b) an NTSC video version, with additional video footage and background commentary, to be distributed on VHS videotape for replay in a standard VCR.

Hardware

The following existing equipment is available to the project and will be used in the production (equipment origin is indicated in parentheses):

Sun Sparc20-ZX/192MB workstation (EVOSTC))
Codonics dye sublimation color printer (EVOSTC)
HP Scanjet II color scanner (PWSSC)
Thinkpad 770 graphics notebook computer (OSRI)
DVD, video I/O, frame grabber, hardware MPEG-I and II (included in ThinkPad)
Proxima92 XGA 500 lumen computer projector (OSRI)
Digital camera, Nikon CoolPix 900-S (personal property J.R.Allen)

The following equipment is requested in this proposal. The additional storage capability and fast access times provided by these devices are required for digital video editing and high speed video delivery:

SyJet high capacity mass storage drive
Philips or Sony Read-write CD-ROM drive

Software

The project will take advantage of a base of currently installed software for image handling and graphic design, at no new cost to EVOSTC. On the Unix platform this includes the ppm-related command-line utilities; the X11-R6 programs imagetool, xfig, xv, snapshot, and imconvert; the standalone applications ghostview, GMT and CDRoast; and the high end scientific visualization system AVS, used for 3-d modelling. In the Windows 95/98 environment, the software base includes lview-pro, photovue, videowave, vmpeg, hypercam, and the Corel Suite 8 programs including Presentations, Capture, CorelDraw, CorelPhotoPaint and Dream3D,. On both platforms, the Java language is used to create applications that allow interactive model simulations/demonstrations which will be core to the presentation. With the exception of the Corel programs and AVS, all of the above is public domain or shareware. Support is sought in

this proposal for purchase of Macromedia Director and Adobe Premiere.

The smaller graphics utilities listed above will be used for basic image manipulation and format conversion. The ppm-related group is particularly useful for script-based batch processing of large volumes of data or large numbers of files. Two-dimensional mapping tasks will be handled using GMT via a library of routines written by Dr. Allen and others in the SEA group. On the PC, basic image utility tasks will be handled by lview-pro, while photovue and ACDSee provides good image sorting, indexing, retrieval and thumbnail display capability. Creative tasks for static graphic frames will be handled within the coordinated Corel suite of applications.

Adobe Premiere 5.0 will provide digital video editing capabilities with advanced features including titles, special effects and efficient compression algorithms for creating video clips (see Ozer, 1997, for a comparative review of video editing software). Macromedia Director will be used for authoring the integrated multimedia production. Since its first release, Director has been widely recognized as authoring software in a class of its own and the tool of choice for professional multimedia productions (Lindstrom, 1994; Olsen, 1997; Vaughan, 1998). Director works by composing a multimedia production one frame at a time using a time-based movie metaphor. A "cast" (palette of multimedia components) is arranged on a "stage" (presentation area) by means of a "score" (instruction grid) allowing up to 148 graphical channels plus separate channels for tempo, transitions and sound tracks. Director is particularly suited to linear and multi-track parallel storyline structures and programming of complex animations, which are the tasks required by this project. It incorporates the low-level scripting language Lingo for extended customization and programming interactivity. Director 6.0 also provides Shockwave output, the industry standard streaming video format for product delivery via the web. Although it presents a steep learning curve, this software provides maximum power for a professional production such as that planned here.

Essential Synthesis Activities

Integrated multidisciplinary synthesis is a prerequisite to generating the content of the expanded multimedia presentation. Ongoing SEA synthesis activities, funded elsewhere as part of the SEA closeout budget (99320-Z), will be leveraged to the advantage of the extended work proposed here. In this regard, SEA program structure will allow efficient use of human resources since Drs. Cooney and Allen are directing and assisting coordination of the synthesis, respectively.

The technologies available to support synthesis activities include SEA's web-based communications and visualization tools. An internal web area or Intranet incorporating file upload capabilities and internal discussion forums allows users to post files directly to the web and engage in online group dialog (Allen and Patrick, 1997). The Intranet is the ideal medium for the work of developing a synthesis, since construction performed online is simultaneously accessible to all participants, and the evolving story can be subject to continual review and refinement through input from the owners of the results being integrated. SEA's advanced visualization capabilities will be used to provide flexible methods for translation of disparate data into common visual form, for communication and comparison of findings between groups (Allen *et al.*, 1997).

SCHEDULE

A. Measurable Project Tasks for FY 99

mid November, 1998	Draft storyboard complete
mid December, 1998	Core model animations drafted
January 31, 1998	Final content complete and approved by SEA team
March 1, 1998	Key graphic and video elements assembled, Director script final form, Lingo programming complete.
March 24-29, 1999	Attend Anniversary Symposium, present electronic synthesis in SEA technical session (Cooney) and in poster session (Allen)
April 1, 1999	Analog video production begins. Pre-review of storyboard by EVOSTC Restoration Office will occur before May 15.
June 30, 1999	Script and media clip list finalized with video production services. Pre-review of script and some media clips by EVOSTC Restoration Office before July 30.
Sept 15-30, 1999	SEA video mastering
April 15, 2000	Deliver final report, FY 99

B. Project Milestones and Endpoints

1. Presentation at 10 Year Anniversary Symposium . . . . . March 24, 1999
2. Video completed . . . . . September 30, 1999

C. Completion Date

September 30, 1999.

PUBLICATIONS AND REPORTS

1. Sound Ecosystem Assessment: Ecological Controls of Pink Salmon and Herring Production in Prince William Sound, Alaska., R.T. Cooney, *et al.* A graphic-intensive electronic synthesis to be presented at the EVOSTC 10 Year Anniversary Symposium., Anchorage, March 24, 1999.
2. NTSC videotape version of #1 for public distribution, title to be determined.

COORDINATION AND INTEGRATION

Coordination among SEA investigators in generating the FY99 presentation will be achieved through existing infrastructure and mechanisms developed for the SEA program, particularly the SEA internal web site, augmented by teleconferences and group meetings. One of the products of this work will be demonstration of effective methods for cross-project integration in the synthesis and reporting phase of multidisciplinary ecosystem studies. It is anticipated that this could serve as a model for future larger-scale integration at the programmatic level among EVOSTC supported ecosystem projects.

PRINCIPAL INVESTIGATORS

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Qualifications

Jennifer Allen has a background in digital image processing, scientific visualization and computer communications. She has been active for four years in the synthesis and communications arenas of the SEA program, including coordination of web-based synthesis activities and production of numerous high profile SEA presentations. Ted Cooney is Lead Scientist of the SEA program. In addition to a distinguished research career in biological oceanography , Dr. Cooney has a successful track record in synthesis undertakings in cooperative multi-disciplinary research. (Biographical sketches below.)

OTHER KEY PERSONNEL

The 13 Principal Investigators of the SEA Program will be centrally involved in crafting the content for the presentation.

Revision 1 4-98
approved T 4-15-98

FY 99 EXXON VALDEZ TRUSTE UNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$0.0
Travel		$0.0
Contractual		$23.9
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$23.9
General Administration		$1.7
Project Total	$0.0	$25.6
Full-time Equivalents (FTE)		0.1
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

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

Dollar amounts are shown in thousands of dollars.

Comments:

Dr. Cooney is contributing his time at no additional cost to this project.

FY 99

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

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 99 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Prepared: 12/14/98

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$6.5
Travel		$0.0
Contractual		$9.7
Commodities		$0.9
Equipment		$2.8
Subtotal	$0.0	$19.9
Indirect		$4.0
Project Total	$0.0	$23.9
Full-time Equivalents (FTE)		0.08
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

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

Dollar amounts are shown in thousands of dollars.

Comments:

FY 99

Project Number: 99361
Project Title: Graphica hniques for Ecosystem Synthesis
Name: Jennifer . . . . llen

FORM 4A
Non-T ee
12/14/ SUM

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

FY 99

Prepared: 12/14/98

Name: Jennifer R. Allen
Agency: NOAA

Non-Trustee
SUMMARY

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1999
Jennifer R. Allen	Info Systems / Communications Specialist		1.0	6.5		6.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.0	6.5	0.0	
					Personnel Total	$6.5

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 1999
none requested						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$0.0

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

FORM 4B
12/14/98 3 of 7
Personnel

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

FY 99

Prepared: 12/14/98

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

FORM 4B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FY 1999
digital video editor (Adobe Premiere or similar)	1.8
Macromedia Director 6.5 (multimedia authoring)	1.3
Macromedia Fireworks (graphics/animation)	0.6
Audio/Video production services	6.0
Contractual Total	$9.7

Commodities Costs:	Proposed
Description	FY 1999
blank cartridges for SyJet, 3@$125	0.4
flash memory for Nikon digital camera, 16MB x 1@$149, 45MB x1@$299	0.3
wide angle lens for Nikon digital camera	0.2
Commodities Total	$0.9

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

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1999
SyJet drive (1.5GB, for video editing)			0.5
Philips Omniwriter CD-Read/Write			1.2
5GB removable hard drive			1.1
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$2.8

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

FY 99

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

FORM 4B
Equipment
DETAIL

Revision 7-6-98
Approved TC 8-13-98

Improved Salmon Escapement Enumeration Using Remote Video and Time-Lapse Recording Technology

Project Number:	99366
Restoration Category:	Monitoring
Proposer:	E. Otis/ADFG
Lead Trustee Agency:	ADFG
Cooperating Agencies:	ADFG
Alaska SeaLife Center:	No
New or Continued:	New
Duration:	1st yr. 3 yr. project
Cost FY 99:	$52.0
Cost FY 2000:	$46.5
Cost FY 01:	$12.3
Cost FY 02:	$0.0
Geographic Area:	Lower Cook Inlet
Injured Resource/Service:	Salmon, commercial fishing

ABSTRACT

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

INTRODUCTION

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

Accurate, reliable estimates of spawner abundance are required to monitor the recovery of damaged salmon resources, set appropriate spawning escapement goals for individual streams, and manage commercial fisheries in season. Because aerial survey cannot always provide this level of information and more accurate methods are prohibitively expensive for streams with marginal escapements, a niche exists that remote video technology may be able to fill. Fishery biologists have long considered the potential for photographic enumeration to eliminate the biases inherent to human derived aerial and tower counts of salmon escapement. In the late 1940's and early 1950's, researcher's experimented with aerial and tower based photography to count sockeye salmon in the Bristol Bay area (see Kelez 1947, Eicher 1953, and Mathisen 1962). While these early experiments showed promise, their feasibility was reduced by the state of technology of cameras and recording equipment from this era.

Many technological advancements have occurred since that time and recent video and time-lapse recording systems have proven effective for capturing remote images of adult (Hatch et. al 1994) and juvenile salmonids in controlled field situations (Irvine et. al 1991). In Chignik, Alaska, the ADF&G is using underwater video equipment to facilitate enumeration of adult salmon passing a deep-water weir (Dave Owens, ADF&G Kodiak, personal communication). The Chignik system is powered by a gas generator and maintained by a field crew. In the Pacific Northwest, researchers are experimenting with stand-alone underwater video systems associated with partial weirs (P. Mundy, P. Mundy and Assoc., personal communication). An unmanned underwater system is probably not practical for most Alaskan streams because the camera would be vulnerable to inquisitive bears and other mammals. In FY99 we propose to develop an

unmanned video system that can be deployed above small streams, out of the reach of bears. The video system will document sockeye and coho salmon escapement into a small lake system. Time-lapse images will be recorded onto a VCR powered by 12-volt batteries. Wind- and/or solar-power generators will maintain the batteries. A weir will be operated concurrently to determine the accuracy of video counts. If FY99 results are promising, in FY00 we will evaluate the camera's performance counting pink and chum salmon escapement in a short, intertidal stream.

NEED FOR THE PROJECT

A. Statement of Problem

Salmon resources and services were injured by the 1989 *Exxon Valdez* oil spill. Accurate, reliable estimates of spawner abundance are required to monitor the recovery of damaged salmon resources, set appropriate spawning escapement goals for individual streams, and manage commercial fisheries in season. Aerial survey estimates of spawning escapement are often biased by conditions (e.g., observer experience/efficiency, timing of flights, etc.) that are difficult to account for, leading to imprecise indices of spawning escapement. Because accurate escapement monitoring is so important for salmon management and documenting the recovery of salmon resources and services, reliable, cost-effective techniques should be developed to improve escapement estimation where aerial survey is currently used.

B. Rationale/Link to Restoration

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

C. Location

Development of this improved escapement monitoring technology will occur in Lower Cook Inlet (Southern Kenai Peninsula). However, project benefits could be realized throughout the

spill area and anywhere in Alaska where aerial survey is currently being used to monitor salmon escapement in small, clear streams.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

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

PROJECT DESIGN

A. Objectives

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

B. Methods

The straightforward nature of this monitoring project precludes the need to test hypotheses. A remote video camera positioned above the stream channel will capture images onto a time-lapse video cassette recorder (VCR). A conventional picket weir will be operated concurrently with the camera so the accuracy of video escapement estimates can be determined. The reliability (i.e., field durability) of the video system will be judged by the percentage of time that it is inoperable or unable to effectively count fish.

We selected Delight Lake outlet to test the video system for several reasons: 1) a low-gradient, clear-water stream exists, on which a weir and video system can readily be operated; 2) the lake is typical of lake spawning sockeye systems where fish are only visible to aerial surveyors while

they're ascending the outlet stream; because fish often disappear when they enter the lake, area-under-the-curve estimates of spawning escapement are problematic; and 3) evaluating the video system on Delight lake provides an opportunity to supplement adult escapement data collected under EVOS Project No. 97254 (Edmundson et al. 1998).

Video

Siting of the camera will be critical to its performance. The preferred stream section will be relatively shallow (<1.5 m), narrow (<20 m) and free of excessive surface turbulence. Pools and slow runs will be avoided as fish may have a tendency to mill about and be counted multiple times. If an overhanging tree is not available to position the camera above the chosen site, a support tower will be erected. The tower will consist of a shortened metal light pole, identical to those observed along many roadways. The 5-7 meter vertical pole will be securely attached to the bank and the horizontal mast arm will extend out over the stream where the downward looking camera will be attached.

A light-green "flash panel" (1.27-cm mesh beach seine) will be fixed to the streambed to enhance the contrast of fish swimming below the camera. In other applications flash panels have proven effective without spooking or entangling fish. A polarizing filter will be attached to the camera to reduce water surface glare; if necessary, v-shaped float logs will be placed upstream of the video site to eliminate surface turbulence. The camera will feed a continuous video signal to a time-lapse VCR that will record one image every 1.0 seconds. This interval will allow a single 160-minute VHS tape to last eight days (assuming 20 hours of recording time/day). The camera's field of view will be sufficiently wide to assure that no fish bypass the video site without being documented on film, facilitating near-census-quality escapement data. The only fish not photographed will be those that pass during about 4.0 hours of darkness. Staff will periodically monitor the site at night to estimate the proportion of the run not captured on film. If necessary, auxiliary lighting will be incorporated so the camera can operate 24 hr/d. This will enable estimation of the total escapement for independent comparison with weir counts.

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

It is possible that microwave technology could allow ADF&G to directly transmit video images to Homer in the near future. This would preclude the need to switch out videotapes, enabling considerable savings in air charter costs. A Homer based videographer recently succeeded in transmitting remote images from Gull Island (Kachemak Bay) to Homer, a distance of approximately 6 miles (Daniel Zatz, personal communication). Further experimentation in the coming months will determine the feasibility of using a repeater to facilitate transmissions up to 100 miles. Remote-video monitoring of salmon escapements, and direct transmission of the images to field offices for analysis and archival onto VHS tapes, would facilitate better quality data than aerial surveys currently provide, and at reduced costs. Developing image-recognition software that enables auto-enumeration would further reduce the labor and costs involved with remotely monitoring salmon escapements (Irvine et al. 1991). The ADF&G will pursue these advancements once the present application proves feasible.

Cross Validation

A conventional picket weir will be operated concurrently with the video camera to provide a basis for determining the accuracy of video counts. Weirs are recognized as the most accurate escapement monitoring technique available (Cousens et al. 1982); in the absence of washouts during freshets, they provide a complete census of the run. The weir and associated field camp will be operated in the same location and manner as Project 97254 (Edmundson et al. 1998). Weir operation and video monitoring will begin at the start of the adult sockeye run (June 15) and continue through its duration into the early coho run (August 31). Aerial surveys of spawning escapement will also be conducted concurrently with video enumeration to provide a basis for comparison between the three escapement monitoring techniques.

Intertidal spawning (FY00)

If remote video proves feasible for enumerating sockeye and coho escapement, we would like to investigate its application for estimating pink and chum salmon escapement into tidally influenced streams. Pink and chum salmon often spawn in intertidal areas where weirs are difficult to operate. Aerial and foot surveys frequently are used to assess escapement in these situations (Bucher and Hammarstrom 1997). It may be feasible to deploy a remote camera in the intertidal section of a stream to document intertidal spawners and simultaneously count salmon escaping upstream. Because many individuals may enter and exit the stream with the tides, the daily escapement of upstream spawners would be tallied as the number of upstream migrants minus the number of downstream migrants. Separate estimates will be made for the number of intertidal spawners by factoring streamlife into an area-under-the-curve estimate of total observed spawners (Hill 1997, Bue et al. 1998a). Total spawning escapement will be estimated by adding the estimated escapements of the upstream and intertidal spawning components of the

run. A weir can be operated above tidal influence to document the actual number of upstream spawners for independent comparison with video counts. Port Dick Creek would be an excellent candidate to pursue this application because it sustains runs of both pink and chum salmon. Pursuing the project on Port Dick Creek also provides an opportunity to continue monitoring the success of project 97139A2 (Dudiak et al. 1998).

C. Cooperating Agencies, Contracts, and other Agency Assistance

Not applicable

SHEDULE

A. Measurable Project Tasks for FY99

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

B. Project Milestones and Endpoints

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

C. Completion Date

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

technology to transmit digital images directly to field stations, and image-recognition software to facilitate auto-enumeration.

PUBLICATIONS AND REPORTS

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

PROFESSIONAL CONFERENCES

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

NORMAL AGENCY MANAGEMENT

Along with monitoring the recovery of injured resources, the proposed project will improve the department's ability to assess and manage salmon resources within the spill area and elsewhere in Alaska. The department has few resources with which to develop new technology; without the Trustee Council's financial support, this project will not be funded in the near future. A unique opportunity exists for the EVOS Trustee Council to add to their legacy by supporting ADF&G's development of a new salmon counting technique that is likely to improve salmon management throughout Alaska.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Does not apply.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

Does not apply.

PROPOSED PRINCIPAL INVESTIGATOR

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Revision - 7/23/98
approved TC 8-13-98

FY 99 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$32.0
Travel		$0.5
Contractual		$4.3
Commodities		$5.6
Equipment		$4.5
Subtotal	$0.0	$46.9
General Administration		$5.1
Project Total	$0.0	$52.0
Full-time Equivalents (FTE)		0.8
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
	$46.5	$12.3			

Dollar amounts are shown in thousands of dollars.

Comments:

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

*The Principal Investigator's salary will be funded entirely by ADF&G.

FY 99

Prepared:

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

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 99 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1999
Field Personnel (15 June through 31 July)						
Maintain and operate adult weir and video equipment						
Carla Milburn	Fisheries Technician II	9B	1.5	3600	1408	6.8
Josephine Ryan	Fisheries Technician II	9B	1.5	3600	1408	6.8
Project Supervision						
Field site and gear preparation, project management,						
video screening and report writing.						
*Edward Otis	Fisheries Biologist II		2.0	0	0	0.0
Mark Dickson	Fisheries Technician IV		4.0	4600	0	18.4
	Subtotal		9.0	11800	2816	
					Personnel Total	$32.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1999
					0.0
RT Homer-Anchorage. Annual EVOS Restoration Workshop	135	1	3	45	0.3
Lodging/food per diem- for 3 days			3	75	0.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.5

FY 99

Prepared:

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

FORM 3B
Personnel
& Travel
DETAIL

FY 99 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Contractual Costs:	Proposed
Description	FY 1999
Air charter to transport camp. 2 round trips @ 1.5 hrs/ trip @ $580.00/hr. (Dehavilland Otter)	1.7
Air charter to support camp (food and supplies) and service remote video equipment, 8 round trips @ 1.25 hrs / trip @ $225 / hr	2.3
Air charter standby 3 hrs. @ 112.50 / hr.	0.3
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$4.3

Commodities Costs:	Proposed
Description	FY 1999
Food: 2 people @ $20.00 / day @ 75 days(2x20x75)	3.0
Consumables: lumber, additional fencing (weir materials), video tape etc.	0.3
100 gals. stove oil @ $1.25 per gallon	0.1
1 marine deep cycle battery (for camp lighting and radio communications)	0.1
4 marine deep cycle batteries (to power video equipment) @ $90.00	0.4
1 kerosene tent heater	0.1
Materials and labor to fabricate remote camera stand and weather/bear proof strongbox to house video equipment	0.9
Miscellaneous electronic supplies	0.2
Pelican case for VCR	0.2
0.5 inch mesh beach seine (16' x 50'); green dipped (for flash panel)	0.3
Commodities Total	$5.6

FY 99

Prepared:

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

FORM 3B
Contractual & Commodities DETAIL

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

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1999
Remote video equipment:			
Underwater camera and video cable/connections	1	1500	1.5
Video Cassette Recorder	1	1800	1.8
Solar or wind powered electrical generation unit (depending on application)	1	900	0.9
Trace C40 Charge Control regulator (with thermal monitoring and LCD option)	1	300	0.3
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$4.5

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

FY 99

Prepared:

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

FORM 3B
Equipment
DETAIL

Revision 8-31-98
approved TC 8-13-98

Synthesis and Publication of Fisheries Research

Project Number:	99367
Restoration Category:	Research
Proposer:	M. Willette, ADFG
Lead Trustee Agency:	ADFG
Cooperating Agency:	None
Alaska SeaLife Center:	None
Duration:	2 years
Cost FY 99:	$ 72,900
Cost FY 00	$ 13,500
Cost FY 01	$ 0
Cost FY 02	$ 0
Geographic Area:	Greater Gulf of Alaska Spill Area
Injured Resource/Service:	Herring, Salmon

ABSTRACT

ADF&G will synthesize and publish the legacy of research conducted on fisheries resources in the Gulf of Alaska spill zone. Many EVOS reports written by ADF&G staff provide key information on injured resources. However, some do not form stand-alone publications, and some contain information suitable for more than one article or are too bulky for publication in their current form. Additional synthesis and editing are needed to transform these from gray literature reports to peer-reviewed publications in scientific journals. In this project, ADF&G staff will synthesize research reports into manuscripts that will then undergo peer review for consideration in the leading fisheries journals in North America.

INTRODUCTION

Projects funded by the EVOS Trustee Council have generated significant quantities of important fisheries-related information during the last decade. Currently, much of this information resides in EVOS-directed final and annual reports that do not receive wide attention. The Commercial Fisheries (CF) Division of ADF&G attempted, whenever possible, to publish research findings in peer-reviewed journals. But, it is not normal agency policy for ADF&G staff to publish in peer-reviewed journals. Consequently, without additional funding, much information will remain unavailable to the fisheries community at large. This project will provide EVOS Trustee Council funding to distill the mass of information in reports that accumulated over the last ten years into a series of papers that will be submitted to peer-reviewed journals. The timing of this process is of the essence as key personnel involved with many of the projects have already left ADF&G employment, and others will leave as the CF Division phases out of EVOS-funded research during FY 1999. Additional syntheses will be increasingly difficult as EVOS reviews of final reports are submitted after the completion of close-out projects.

NEED FOR THE PROJECT

A. Statement of Problem

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

B. Rationale/Link to Restoration

The Trustee Council has made a major investment into the study of the effects of the oil spill on fisheries resources in the Gulf of Alaska. Substantial efforts were also funded to improve the management of injured species that support commercial, sport, and subsistence fisheries. In recent years the Trustee Council increasingly emphasized the need to publish research findings

and solicited proposals to integrate research results into peer-reviewed publications. This project directly responds to the Council's goal to move EVOS reports into the peer-reviewed literature in order to provide the scientific community with ready access to and a broad understanding of the effects of the spill and the efforts to ameliorate them.

C. Location

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

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

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

PROJECT DESIGN

A. Objective

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

B. Methods

1. Review reports of fisheries research conducted the past nine years to identify publishable units

2. Collate, coordinate, and integrate results from an array of projects to provide clear evaluation of impacts, results of restoration activities, and showcase improved understanding and management of salmon and marine fisheries resources resulting from Trustee Council-sponsored agency research

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Celia Rozen is housed ½ time at the Alaska Resources Library and Information Center (ARLIS). ARLIS capabilities will be used by Celia to provide archival documents, literature searches, and other information services necessary for manuscript synthesis.

SCHEDULE

A. Measurable Project Tasks for FY99

Manuscript Title	Expected Submission
Physical and biological factors affecting growth of Pacific herring in Prince William Sound, M. Willette, G. Carpenter, D. Evans, Canadian Journal of Fisheries and Aquatic Sciences.	June 1
Comparison of ground and aerial survey estimates of Pacific salmon spawners, M. Willette, B.G. Bue, D. Evans, S.M. Fried, Transactions of the American Fisheries Society.	July 15
Homing and straying patterns of coded-wire tagged pink salmon in Prince William Sound, D. Sharp, G. Carpenter, M. Willette, D. Evans, B.G. Bue, S.M. Fried, Transactions of the American Fisheries Society.	September 1
Factors affecting marine survival of wild pink salmon in Prince William Sound, 1990-1991. M. Willette, D. Sharp, G. Carpenter, Trans. Amer. Fish. Soc.	September 30

B. Project Milestones and Endpoints

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

C. Completion Date

The project will be completed in FY00.

PUBLICATIONS AND REPORTS

Topics proposed for FY99 that require a major writing effort by CF Division staff include:

Title: Physical and biological factors affecting growth of Pacific herring in Prince William Sound

The mechanisms underlying cyclic changes in growth of herring in the northern Gulf of Alaska

are currently unknown. Herring from Prince William Sound (PWS) and Sitka Sound exhibit long-term cyclic changes in average body size at age (Fritz Funk, ADFG, Juneau, unpublished data). The lowest observed average body sizes for PWS herring coincided with a period of historic high abundance followed by a catastrophic population decline associated with outbreaks of viral hemorrhagic septicemia virus and *Ichthyophonus hoferi* (Marty et al. 1998). Although links between herring energetic condition (growth) and disease susceptibility are not yet well understood, the observed drastic population decline may have been related to reduced density-dependent growth leading to decreased fitness and disease resistance. Determining the underlying distribution of growth patterns can provide improved inputs into population dynamics models that are used to establish harvest guidelines.

Fish grow in response to the extrinsic influences of their environment constrained by the intrinsic influences of genetic predisposition for growth and size already attained (Weatherley and Gill 1987, Weisberg 1993). The effects of population size and environmental conditions on growth have been studied by a number of investigators (Peterman and Bradford 1987, Anthony and Fogarty 1985, Rijnsdorp and van Leeuwen. 1992, Kreuz et al. 1982, Stocker et al. 1985, Hagen and Quinn 1991), primarily because of the consequences that growth variation can have on reproductive potential through its influences on fecundity and spawn timing (Ware and Tanasichuk 1989), natural mortality, recruitment, and age at maturity (Schmitt and Skud 1978, Haist and Stocker 1985). Haist and Stocker (1985) stated that factors affecting growth can be of fundamental importance in understanding the dynamics of exploited populations. Growth variation also has a strong impact on selection of appropriate harvest policies through the use of demographic models that reflect these natural processes (Methot 1997, Tanasichuk 1997).

We will examine two approaches to analyses of environmental-growth relationships. The first approach involves time series and multiple regression analyses to examine relationships between time series of growth, population size, and environmental or ecological conditions (Anthony and Fogarty 1985, Pereira et al. 1995). A second approach involves examination of the variation of growth that can be explained by time-dependent factors such as age, year and year class. This approach involves application of general linear models to determine variation explained by age and year (Weisberg 1993) or construction of randomization tests to compare variation explained by year verses year class (Hagen and Quinn 1991). It is expected that a combination of these approaches may provide insight into both the causes of changes in herring growth and the relative magnitude of these influences. Our analyses of environmental effects will utilize ocean temperature and salinity data from station GAK 1 located at the entrance to Resurrection Bay, upwelling indices for the northern Gulf of Alaska (Bakun 1973), zooplankton biomass measured at Armin F. Koernig Hatchery since 1980, and pollock biomass estimates for the northern Gulf of Alaska (Hollowed et al. 1997).

We will also construct a revised time series of herring abundances in PWS using techniques developed by restoration project 99166, and apply these new estimates in analyses of density-dependent growth. Project 99166 identified loss of eggs between spawn deposition and dive surveys and adjustments for diver-specific bias in visual egg counts as important factors affecting

the accuracy of spawn deposition biomass estimates (Willette et al. 1998a). Application of diver calibration models including all available data and models of egg loss as a function of cumulative time of air exposure (Rooper 1996) resulted in herring biomass estimates 14 to 72% greater than previously reported (Willette et al. 1998a). The techniques developed by project 99166 will be applied to historical spawn deposition data (1984, 1988-1992). Revised spawn deposition biomass estimates will then be incorporated into age-structured assessment (ASA) models to reconstruct the historical time series of herring abundances in PWS.

The results from our analyses may be further incorporated into ASA models in several ways. Age-structured assessment models require estimates of catch at age in all fisheries exploiting a stock, gear selectivity, recruitment, natural mortality, age at maturity, weight at age, and spawning biomass (Funk 1995, Otis and Bechtol 1997). Herring growth may be related to (1) recruitment success through density-dependent effects on juvenile growth and overwinter survival, (2) natural mortality through effects on disease susceptibility (Marty et al. 1996, 1998), or (3) age at maturity through effects on gonad maturation.

Title: Comparison of ground and aerial survey estimates of Pacific salmon spawners

Accurate estimates of the number of Pacific salmon spawners are needed to determine appropriate escapement goals and regulate harvests. In Prince William Sound, the number of pink salmon spawners in 208 index streams is visually estimated by observers in fixed-wing aircraft every 5 to 7 days during the spawning season. Aerial surveys allow managers to monitor escapement at frequent intervals over large areas at relatively low cost, but the accuracy of aerial surveys is sometimes poor if counts are not adjusted for observer efficiency. Hilborn et al (*in press*) evaluated various methods of estimating escapement using aerial methods and indicated that there is a great deal of uncertainty in escapement estimates based on aerial observations. Bue et al. (1998) recommended that weirs be maintained on a subset of the 208 index streams to estimate aerial observer efficiency and monitor changes in stream life. Ground surveys are another technique that may provide relatively accurate escapement estimates, as well as a means for monitoring observer efficiency and stream life. Ground surveys are more costly than aerial surveys but less costly than weirs. We propose to utilize data produced by NRDA Fish/Shellfish Study No. 1 to (1) evaluate the accuracy of ground survey counts, (2) compare the accuracy and precision of ground and aerial survey counts, (3) the compare the efficiencies of ground and aerial surveyors, and (4) compare the frequencies of aerial and ground surveys required to obtain equally accurate escapement estimates. The precision and accuracy of aerial and ground counts will be incorporated into analyses of necessary survey frequencies. The results from our analyses will build on the work by Bue et al. (1998) and Hilborn et al (*in press*), and will be used to evaluate methods for improving the ADF&G escapement enumeration program.

Title: Homing and straying patterns of coded-wire tagged pink salmon in Prince William Sound

Salmon management in Alaska is based upon knowledge of population or stock units. Homing and straying patterns and subsequent interbreeding largely determines population structure. During the late 1980's, production of hatchery-reared pink salmon increased dramatically in Prince William Sound. With the number of hatchery to wild salmon in the adult return ranging from 3 to 10 in recent years. Few studies have estimated straying rates of Pacific salmon (Quinn and Fresh 1984), but straying rates of coho salmon in British Columbia were about 2% (Labelle 1992). If hatchery pink salmon in PWS stray at this rate, significant numbers of hatchery strays may occur in streams because of the much greater abundance of hatchery salmon. This is cause for concern, because interbreeding of hatchery and wild salmon may lead to reduced productivity of wild salmon due to outbreeding depression (Gharrett and Smoker 1991). Furthermore, harvest management strategies for salmon in Alaska are designed to achieve wild salmon escapement goals. These strategies are based on the assumption that spawners observed in streams are wild fish. We propose to utilize data produced from NRDA Fish/Shellfish Projects No. 1 and 3 to evaluate homing and straying patterns of wild- and hatchery-origin pink salmon in Prince William Sound. During the years these studies were conducted, coded-wire tags were applied to pink salmon fry released from all hatcheries in the sound as well as fry migrating from 6 streams. Tagged adults were recovered at each of the hatcheries and at numerous streams during escapement enumeration surveys. These recoveries provided irrefutable evidence of widespread straying of pink salmon and were the basis for continuing research (Habicht et al. *in press*, Joyce and Evans *in prep*; Restoration Projects 96076-98076). This paper will document the straying found in 1991 and 1992. We will also examine whether an estimate of the minimum straying rate for hatchery and wild stocks is obtainable and include the findings if appropriate.

Title: Factors affecting marine survival of wild pink salmon in Prince William Sound, 1990-1991.

The Sound Ecosystem Assessment (SEA) program is presently investigating factors affecting marine survival of pink salmon in PWS. However, SEA field investigations and model validation work has focused primarily on hatchery-reared salmon. This approach was taken, because process-oriented studies of predation mechanisms may not be practical in areas of very low juvenile salmon abundance due to the difficulty of measuring predation rates under these conditions. In addition, an extensive time series of hatchery coded-wire tag data is available for analyses of mechanisms affecting juvenile migration, growth and marine survival. These data are generally not available for wild salmon. However, in 1990 and 1991 ADFG enumerated and tagged wild pink salmon emigrating from 6 streams in western PWS during 3-4 day periods each year. Recoveries of returning adults in streams and commercial fisheries enabled estimation of marine survival. We propose to utilize the data produced by NRDA Fish/Shellfish Project No. 3 to examine the biological factors affecting marine survival of wild pink salmon. Wild pink salmon appear to emigrate from streams over a relatively long period of time (Kirkwood 1962), whereas hatcheries typically time fry releases to coincide with the spring zooplankton bloom. Stream emigration timing and sizes of wild fry upon emigration are probably determined by spawn timing, egg size and stream incubation temperatures (Holtby et al. 1989), whereas

hatcheries rear juveniles in net pens to achieve the largest possible size before release into the bloom. The proposed paper will document seasonal and interannual variability in wild fry emigration timing, and examine survival rates relative to ocean temperature, zooplankton density, and fry size during the initial 30 days of marine residence of each coded-wire tag group. Survival rates of wild salmon will also be compared to those of hatchery salmon entering the ocean at similar times.

PROFESSIONAL CONFERENCES

None

NORMAL AGENCY MANAGEMENT

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

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

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

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

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Cooney, R.T., T.M. Willette, S. Sharr, D. Sharp, J. Olsen. 1995. The effect of climate on Pacific salmon production in the northern Gulf of Alaska: examining the details of a natural experiment. In Proceedings of the International Symposium on Climate Change

and Northern Fish Populations, Can. Spec. Publ. Fish. Aquat. Sci. 121: 475-482.

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

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

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

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

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

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

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

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

Seeb, J.E., C. Habicht, J.B. Olsen, P. Bentzen, J.B. Shaklee, and L.W. Seeb. 1998. Allozyme, mtDNA, and microsatellite variants describe structure of populations of ink and sockeye salmon in Alaska. North Pacific Anadromous Fish Commission Bulletin Number 1:300-318.

Willette, T.M., R.T. Cooney, K. Hyer. 1998. An evaluation of some factors affecting piscivory during the spring bloom in a subarctic embayment, Canadian Journal of Fisheries and Aquatic Sciences (in review).

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

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

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

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

None

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Revision 8-3-98
Approved TC 8-13-98

FY 99 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999						
Personnel		$63.4						
Travel		$0.0						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$63.4		Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
General Administration		$9.5						
Project Total	$0.0	$72.9		$13.5	$0.0	$0.0		
Full-time Equivalents (FTE)		0.9						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: Estimated costs for FY 2000 cover publication costs (page charges, etc.) for 4 papers and 1 mm of the PI's time for revisions

NOTE: The Trustee Council approved $73.1 for this project. The budget was subsequently revised downward.

FY 99

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

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: 7/98

FY 99 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1999
Willette	FB III	18F	6.0	6309		37.9
G. Carpenter	Fishery Biologist II	16C	5.0	5093		25.5
	Subtotal		11.0	11402.0	0.0	
					Personnel Total	$63.4

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1999
				Travel Total	$0.0

FY 99

Prepared: 7/98

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

FORM 3B
Personnel
& Travel
DETAIL

FY 99 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Contractual Costs:	Proposed FY 1999
Description	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed FY 1999
Description	
Commodities Total	$0.0

FY 99

Prepared: 7/98

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

FORM 3B
Contractual & Commodities DETAIL

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

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

Existing Equipment Usage:	Number of Units	Inventory Agency
Description		

FY 99

Prepared: 7/98

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

FORM 3B
Equipment
DETAIL

Revised 6/26/98
Approved TC 8-13-98

Seasonal Map Series Depicting Environmentally Sensitive Areas in Prince William Sound, Alaska - Proposal #1

(revised submission, 6/26/98)

Project Number:	99368
Restoration Category:	General Restoration
Proposer:	Hazardous Materials Response and Assessment Division, National Oceanic and Atmospheric Administration (NOAA)
Lead Trustee Agency:	NOAA
Cooperating Agencies:	U.S. Forest Service
Alaska Sea Life Center:	No
Duration:	1st year, 1-year project
Cost FY 99:	$37.3 (an additional $20.0 is necessary for the project and is being sought as addressed in section C. Cooperating Agencies, Contracts, and Other Agency Assistance)
Geographic Area:	Prince William Sound
Injured Resource/Service:	All resources and services injured by the *Exxon Valdez* spill, since it is a sensitive areas mapping project

ABSTRACT

A series of seasonal maps depicting environmentally sensitive areas in Prince William Sound will be produced in both hardcopy and digital formats. A previous series was produced in paper format in 1988. However, these maps need to be updated with new information on the distribution, abundance, life history, and sensitivity of the natural resources in Prince William Sound. NOAA proposes to integrate and depict the most current information onto an updated series of maps, produced at a scale of 1:250,000 (previous maps were at 1:333,300). The maps will be produced as posters, folded maps, and a digital product.

INTRODUCTION

One of the primary objectives of spill response, after protecting human life, is to reduce the environmental consequences of the spill and clean-up efforts. This objective is best achieved if the locations of sensitive resources are identified in advance of a spill so that protection priorities can be established and clean-up strategies identified. The most widely used approach to sensitivity mapping in the United States is known as the Environmental Sensitivity Index (ESI). This approach systematically compiles information in standardized formats for shoreline sensitivity, biological resources, and human-use resources. The strategy emphasizes standardization in the following areas: definitions of shoreline sensitivity rankings; data structures for organizing resource information; and map formats, for both electronic and hard copy output.

ESI maps have been prepared for Prince William Sound in two formats: 1) a detailed atlas consisting of 42 maps at a scale of 1:63,360 published in 1983; and 2) a series of four seasonal maps each at a scale of 1:333,300 published in 1988. The summary maps are a subset of the more detailed data included in the ESI atlas, focusing on the most sensitive resources. Summary maps have also been produced for Cook Inlet/Kenai Peninsula in 1994 and Kodiak Island/Shelikof Straits in 1997.

NOAA proposes to update the Prince William Sound summary maps, integrating the new information learned from the numerous studies of the impact of the *Exxon Valdez* oil spill. This process will also address the need to update the identification and prioritization of sensitive areas for protection, since the natural resource agencies will be involved in providing data and reviewing the maps.

NEED FOR THE PROJECT

A. Problem Statement

The seasonal sensitivity maps of Prince William Sound have been shown to be a valuable tool for oil spill planning and response. The maps were published in 1988, thus they are out of date as well as being out of print.

B. Rationale/Link to Restoration

Updating of the seasonal summary maps will satisfy several needs:

1) The existing maps are out of date, particularly considering the extensive work conducted in the Sound since the *Exxon Valdez* spill. This synthesis of the most recently available environmental information will guide restoration planners, scientists, and responders in identifying and protecting the most sensitive areas.

2) The existing maps are also out of print. NOAA considered reprinting them in the last few

years to meet the current demand for copies.

3) In addition to the hardcopy map products, there will be a digital version of the maps and data, which provides other types of use.

4) The process of gathering data and reviewing the maps will provide the opportunity for resource agencies to discuss the concepts of what resources are most sensitive and require priority protection.

C. Location

The area to be covered by the seasonal sensitivity maps will be the same as the existing maps, that is, all of Prince William Sound and the Copper River delta.

COMMUNITY INVOLVEMENT & TRADITIONAL ECOLOGICAL KNOWLEDGE

As in past seasonal mapping projects, local communities are involved in providing data, such as for key subsistence areas, and reviewing the draft maps. NOAA will invite representatives from each community in the Sound to participate in all planning and data-collection activities, and make sure that a set of review maps is provided to each community. NOAA will work with Hugh Short, the Spill Area-Wide Coordinator, and the network of community facilitators to make sure that the communities in the Sound are award of the mapping project and given the opportunity to participate.

PROJECT DESIGN

A. Objectives

The objective of the mapping project is to:

Update the seasonal sensitivity map series for Prince William Sound, integrating the results of recent studies on the biological and human-use resources in the area since the *Exxon Valdez* oil spill.

B. Methods

NOAA has taken the lead in the U.S. in developing standards for sensitivity mapping for oil spill planning and response. Detailed guidelines for developing sensitivity maps have recently been revised and described in an October 1997 manual, *Environmental Sensitivity Index Guidelines, Version 2.0,* published as NOAA Tech. Memo. NOS ORCA 115, by the Hazardous Materials Response and Assessment Division. The Prince William Sound seasonal sensitivity map series will be produced in accordance with these guidelines, following the map content and format as used in the recent projects in Cook Inlet/Kenai Peninsula and Kodiak Island/Shelikof Strait.

The methods for collecting data and determining which resources are to be included on the maps are well defined, since NOAA has produced similar map products recently. We have good working relationships with all of the key data providers and technical experts who will be reviewing the draft maps. We have established protocols for obtaining the necessary data from each source and for the review process.

There are several key data sources. Alyeska Pipeline Service Company (Alyeska) has developed a computer database for Prince William Sound and adjoining areas on the south-central coast of Alaska. The software, called the Graphical Resource Database (GRD), holds the sensitive area data of the Prince William Sound Tanker Oil Discharge Prevention and Contingency Plan. The geographic coverage of the GRD spans an approximately 500-mile-long region that includes the Copper River Delta, Prince William Sound, the lower Kenai Peninsula, lower Cook Inlet, the Kodiak Archipelago, and Shelikof Strait. The GRD consists of 105 layers of digital data records of biological resources (such as seabird colony sites and sea otter concentration areas), socioeconomic resources (such as commercial fishing areas and small boat harbors), and shoreline types. The expansion and update effort were coordinated by a committee of federal and state natural-resource trustee agencies (including the Alaska Department of Environmental Conservation, Alaska Department of Fish and Game, U.S. Fish and Wildlife Service, and NOAA), citizens oversight groups, Alyeska, and oil shipping companies. The project is currently undergoing maintenance as data updates are intermittently provided by trustee agencies.

The GRD will be a primary source of digital data for the seasonal maps in Prince William Sound. However, primary data providers will be contacted, particularly for those databases that are regularly updated by management agencies. Examples include the USFWS digital database and colony status record files for seabird colonies and eagle nest sites, and the ADF&G catalog of waters important to anadromous fish.

Description of Sensitive Resources to be Shown on the Seasonal Maps

ESI atlases are comprised of three general types of information:

1) Shoreline Habitat Classification – Shoreline habitats are ranked according to a scale relating to biological sensitivity, natural persistence of oil, and ease of cleanup.

2) Biological Resources – Includes oil-sensitive animals and non-shoreline habitats such as submerged aquatic vegetation.

3) Human-Use Resources – Specific areas that have added sensitivity and value because of their use by humans, such as high-use amenity beaches, parks, marine sanctuaries, water intakes, and archaeological sites.

The seasonal maps show a sub-set of the most sensitive resources. Thus, only the most sensitive shoreline types will be shown, namely:

ESI 7	Exposed tidal flats

ESI 9	Sheltered tidal flats
ESI 10	Marshes

Since so much of the shoreline in Prince William Sound consists of ESI 8, sheltered rocky shores, this shoreline type will not be mapped (it was not mapped in the original series). The shoreline types will be obtained from the GRD database, which was originally digitized from the 1983 ESI maps. During the review process, any significant changes in these shoreline types will be addressed.

NOAA has developed a standard biological scheme which identifies seven major biological elements, based on major taxonomic and functional groupings. Each element is divided into groups of species, or sub-elements, with similar taxonomy, morphology, life-history, and/or behavior relative to oil spill vulnerability and sensitivity. Table 1 lists the biological resources to be included on the seasonal sensitivity maps for Prince William Sound. Table 2 lists the human-use resources to be included on the maps. This list will be finalized based on meetings with community representatives, natural resource trustees, and response organizations.

TABLE 1. Biological resources to be included on the seasonal sensitivity map series for Prince William Sound.

Data element	Sub-element	Areas/Sites to be mapped
Marine Mammal	Pinniped (harbor seal and northern sea lion)	Haulouts, concentration areas
	Sea otter	Concentration areas
	Whale	Migratory or other concentration areas
Terrestrial Mammal	Deer	Intertidal concentration areas
	Small mammal (river otter)	Aquatic fur-bearer concentrations
Bird	Seabirds (see list in text)	Nesting colonies; concentration areas
	Raptor (bald eagle)	Nesting sites; concentration areas
	Shorebird	Migratory concentration areas
	Waterfowl	Wintering and migratory concentrations

	Passerine	Threatened/endangered or rare occurrences
Fish	Anadromous fish	Spawning streams
	Pacific herring	Spawning areas
Shellfish	Bivalve	Harvest areas; abundant beds
Habitat/Rare Plant	Rare plant	Threatened/endangered or rare species or communities
	SAV	Submerged aquatic vegetation

TABLE 2. Human-use resources to be included on the seasonal sensitivity map series for Prince William Sound.

Data element	Sub-element	Comments
Recreation/Access	Marina	Site
	Landing strip	Site
Management Area	National Park	Boundary
	State Park	Site
	National Forest	Boundary
	National Wildlife Refuge	Boundary
	State Critical Habitat Area	Boundary
Resource Extraction	Aquaculture site	Hatcheries
	Commercial fishery	Set-net sites
	Subsistence fishing	Designated key harvest sites
Cultural Resources	Archaeological site	Water-, coastal-, wetland-associated
	Historical site	Water-, coastal-, wetland-associated

Other Features	Oil facilities	
	Port facilities	
	Communities	
	Political boundaries	Boroughs
	Roads	
	Dispersant pre-approval zones	
	Annotation	

Biology and Human-Use Compilation and Digitization

The collection of biological and human-use data requires a close working relationship with federal, state, and local resource and information-system experts, beginning at the start of the project and continuing until all data are reviewed. The general sequence of data compilation entails:

- Making contacts with scientists and resource managers who can provide expert knowledge and suggest relevant source materials;
- Gathering as much digital information as possible before meeting with experts;
- Reviewing existing hardcopy data sources;
- Meeting with individuals or groups of experts to delineate the locations of resources for which hardcopy or digital data are not available;
- Drawing resource distributions for non-digital data onto compilation maps based on hardcopy data and expert opinion; and
- Recording non-spatial or attribute data, and associating it with the resource locations delineated on the maps.

Based on the most recent mapping projects, NOAA has developed a template for the types of data to be included, the cartographic styles, the text, and the legend, which can be efficiently modified for each area. The seasonal map for Prince William Sound will be designed from this template with the necessary changes to reflect the special requirements of the area.

Four sets of the draft maps will be printed for review by all appropriate agencies and

communities. The review maps will include all data, symbology, legends, notations, etc., to be shown on the final maps. NOAA will coordinate the review of the maps.

When the review information comes back, all edits will be entered and a check of all final data will be made. The data are then converted to the NOAA data structure with unique identification numbers, lookup tables, and data tables, and the final data sets and accompanying digital and hardcopy documents are prepared.

The production of the negative film separations is a completely digital process. The negative film separations will be quality-checked by generating a Chromalin color proof consisting of four photosensitized overlays, each in a different process color (CMYK), precisely registered and laminated to a white backing material. When the color proof meets quality standards, the films will be used to generate the printing plates which transfer the ink to the paper on the printing press, producing the best quality printing at the least cost for larger quantities of maps.

Two types of maps will be printed:

1) Full-color posters (35 x 40 inches) printed at 1:250,000 on heavy paper

2) Full-color maps at the same size but printed on water- and tear-resistant paper and folded, so they will be easy to carry and use in the field.

NOAA will print 1500 copies of the posters and 200 copies of the folded field maps.

Digital data will be provided for the study area. The data will be distributed on CD-ROM for $20/copy (approximately the cost of reproduction). The CD-ROM will contain the map images in PDF format. This format allows the maps to be printed using free included software and common office printers. In this format, anyone with a personal computer or access to a commercial copy center can view and print the maps. Map images can also be reproduced on large format color printers for high quality reproduction.

The CD-ROM will contain digital data suitable for use with desktop mapping software such as ArcView and Map Info. Additional information on these formats can be found at: http://response.restoration.noaa.gov/esi/sample.html. Finally the CD-ROM will contain data in formats suitable for long term maintenance and updating using a relational database structure and more advanced GIS software. These formats are documented in the NOAA publication "Environmental Sensitivity Index Guidelines, version 2.0" which can also be found at:http://response.restoration.noaa.gov/esi/sample.html

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Cooperating agencies who will provide information and review data include:

U.S. Forest Service, Chugach National Forest: Contacts and cooperation have been established

with Karen Murphy, biologist with the Chugach National Forest, who is the principal investigator on the PWS Human Use and Wildlife Disturbance Model. Our project will be establishing locations and concentrations of wildlife against which the human-use data for PWS will be compared. These two projects are particularly amenable since both data sets will be generated in ArcInfo GIS format. In addition, we hope to be able to use Karen as a local knowledge source for PWS since she is already quite familiar with many of the biological projects that have been and are being conducted under the EVOS Trustee umbrella.

Alaska Department of Fish & Game

Alaska Department of Natural Resources

U.S. Fish & Wildlife Service

National Marine Fisheries Service

Prince William Sound Science Center

Communities of Chenega Bay and Tatitlek

Prince William Sound Regional Citizens Advisory Council

Also, funds and in-kind contributions have been obtained from a wide range of partners involved in oil spill planning and response.

Alyeska will provide their natural-resource databases.

Alaska Department of Conservation has agreed to provide funding so that the state resource agencies can budget adequate time to provide data & to review the draft ESI maps.

The U.S. Coast Guard has agreed to submit $10K in their FY99 budget for this mapping effort. We will know sometime this summer if the funding is approved.

The PWS Regional Citizens Advisory Council approved $10K for this project June 17, 1998.

Summary of Proposed Project Funding Arrangement (several yet to be confirmed)

Coast Guard	$10
PWS RCAC	$10
EVOS Trustee Council	$30
EVOS (Karen Murphy local liaison)	$5.2

SCHEDULE

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

The project schedule is outlined below.

October 1:	Begin data collection and evaluation
December 1:	Finalize the list of resources to be mapped
March 1:	Send out draft maps for review
April 15:	Review maps returned for final editing
June 15:	Digital data complete
July 15:	Color separates completed and approved; printing of maps advertised for bids
September 30:	Printed maps and digital data delivered

B. Project Milestones and Endpoints

The milestones and endpoints for this project are straightforward: Printed maps and a digital database, completed within one year. The schedule is shown above.

C. Completion Date

The maps and digital databases will be completed during FY99.

PUBLICATIONS AND REPORTS

There are no planned publications or reports, other than the maps themselves, the digital data, and the metadata.

PROFESSIONAL CONFERENCES

None anticipated.

NORMAL AGENCY MANAGEMENT

Although NOAA HAZMAT is in the normal business of making ESI maps throughout the United States, updating the PWS summary ESI map series would not normally receive attention until much later. The last edition was developed in 1988 and, as a result, retains adequate accuracy for use in oil spill response. Also, since 1989, Alyeska has developed a Graphical Resource Database (GRD) of the biological and human-use resources of PWS that was last updated in 1995. This digital-only product has been made available to all the resource agencies in a read-only version (the files are in a rather proprietary, arcane format that makes that virtually inaccessible). Currently there is a national drive to update and convert ESI maps to a digital format, and NOAA HAZMAT is heavily involved in this effort. Considering the vast amount of sensitive U.S. coastline and the present status of the PWS resource data, NOAA would not be undertaking this summary map ESI update of PWS as part of its normal activities in the near future. Yet we recognize the vast amount of new data that has been generated with the EVOS Restoration Project. This ESI summary mapping project will allow us the unique opportunity to collate, digitize, and display all this data in poster form and in a digital data format that is consistent and uniform, thus making the information much more accessible to a much larger audience.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

There will be a high degree of coordination among Trustee and management agencies in all phases of data gathering and map review. Interaction would be initiated with principal investigators of the SEA, APEX, and NVP ecosystem projects to ascertain new information that has been developed on locations and areas of concentrations of biological species that populate the Sound. Contact with other principal investigators and review of their work would also be conducted to obtain information pertinent to this summary environmental sensitivity mapping effort.

In particular, contacts and cooperation have been established with Karen Murphy, biologist with the Chugach National Forest, who is the principal investigator on the PWS Human Use and Wildlife Disturbance Model. Our project will be establishing locations and concentrations of wildlife against which the human-use data for PWS will be compared. Similarly, her modeling project may be able to supply some data layers to assist in our mapping effort. These two projects are particularly amenable, since both data sets will be generated in ArcInfo GIS format. In addition, we hope to be able to use Karen as a local knowledge source and liaison for PWS since she is already quite familiar with many of the biological projects that have been and are being conducted under the EVOS Trustee umbrella.

PROPOSED PRINCIPAL INVESTIGATOR

John Whitney, NOAA HAZMAT, Anchorage, Alaska

PRINCIPAL INVESTIGATOR QUALIFICATIONS

Mr. Whitney is the NOAA Scientific Support Coordinator for Alaska. He has managed the last three seasonal sensitivity mapping projects conducted by NOAA and the U.S. Coast Guard, namely Cook Inlet/Kenai Peninsula, Kodiak Island/Shelikof Strait, and the Pribilof Islands.

OTHER KEY PERSONNEL

Robert Pavia, Chief, HAZMAT Scientific Support Coordination Branch

Jill Petersen, HAZMAT Geographic Information System Specialist

Revi 6/23/98
Approved TC 8-13-98

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized	Proposed	PROPOSED FY 1999 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
	FY 1998	FY 1999				$5.2		$32.1
Personnel	$0.0	$4.5						
Travel	$0.0	$5.4						
Contractual	$0.0	$24.0						
Commodities	$0.0	$1.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$34.9		Estimated 2000	Estimated 2001			
General Administration	$0.0	$2.4						
Project Total	$0.0	$37.3		$0.0	$0.0			
Full-time Equivalents (FTE)	0.0	0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$20.0		$0.0	$0.0	$0.0	$0.0	

Comments:

The total budget for this project is $56,028. The budget request to the Trustee Council is $37,300. The difference reflects cost sharing of $20,000 as follows: USCG - $10,000 contingent upon approval of this amount in FY99 budget. Chances are excellent.
PWS RCAC - $10,000 approved by Executive Council on 6/17/98.

1999

Prepared: 6/23/98

Project Number: 99368
Project Title: Seasonal Environmental Sensitive Maps
Lead Agency: NOAA

FORM 2A
MULTI-TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$0.0
Travel		$5.4
Contractual		$24.0
Commodities		$1.0
Equipment		$0.0
Subtotal	$0.0	$30.4
General Administration		$1.7
Project Total	$0.0	$32.1
Full-time Equivalents (FTE)		0.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 2000	Estimated FY 2001			

Dollar amounts are shown in thousands of dollars.

Comments:

1999

Project Number: 99368
Project Title: Seasonal Environmental Sensitive Maps
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1999
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.0	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1999
Seattle-Anchorahe-Valdez-Seattle	927.0	3	12	215.0	5,361.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5,361.0

1999

Prepared:

Project Number: 99368
Project Title: Seasonal Environmental Sensitive Maps
Agency: NOAA

FORM 3B
Personnel
& Travel
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:		Proposed
Description		FY 1999
printing of maps		22,000.0
duplication and mailing costs		2,000.0
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$24,000.0

Commodities Costs:	Proposed
Description	FY 1999
printer/plotter paper	500.0
printer/plotter suplies	250.0
base maps	250.0
Commodities Total	$1,000.0

1999

Project Number: 99368
Project Title: Seasonal Environmental Sensitive Maps
Agency: NOAA

FORM 3B
Contractual & Commodities DETAIL

Prepared:

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

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

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

1999

Prepared:

Project Number: 99368
Project Title: Seasonal Environmental Sensitive Maps
Agency: NOAA

FORM 3B
Equipment
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1998	Proposed FY 1999						
Personnel		$4.5						
Travel		$0.0						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$4.5		Estimated FY 2000	Estimated FY 2001			
General Administration		$0.7						
Project Total	$0.0	$5.2						
Full-time Equivalents (FTE)		0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1999

Project Number: 99368
Project Title: Seasonal Environmental Sensitive Maps
Agency: USFS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1999
K. Murphy	wildlife biologist	GS 9/6	1.0	4500.0		4,500.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.0	4500.0	0.0	
					Personnel Total	$4,500.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1999
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

1999

Prepared:

Project Number: 99368
Project Title: Seasonal Environmental Sensitive Maps
Agency: USFS

FORM 3B
Personnel
& Travel
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed FY 1999
Description	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed FY 1999
Description	
Commodities Total	$0.0

1999

Project Number: 99368
Project Title: Seasonal Environmental Sensitive Maps
Agency: USFS

FORM 3B
Contractual & Commodities
DETAIL

Prepared:

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

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

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

1999

Prepared:

Project Number: 99368
Project Title: Seasonal Environmental Sensitive Maps
Agency: USFS

FORM 3B
Equipment
DETAIL

Revised 7-6-98
Approved TC 8-13-98

Effects of Harbor Seal Metabolism on Stable Isotope Ratio Tracers

Project Number:	99371
Restoration Category:	Research
Proposer:	D. Schell/UAF
Lead Trustee Agency:	ADFG
Cooperating Agencies:	None
Alaska SeaLife Center:	Yes
New or Continued:	New
Duration:	1st yr. 3 yr. project
Cost FY 99:	$110.2
Cost FY 2000:	$101.7
Cost FY 01:	$101.7
Cost FY 02:	$0.0
Geographic Area:	Prince William Sound, Gulf of Alaska
Injured Resource/Service:	Harbor seal

ABSTRACT

A major concern with the use of stable isotope tracers in ecosystem studies is the fidelity with which ratios are transferred up food chains. Use of specific habitats or prey cannot be assessed if geographic gradients in isotope ratios are laid on top of trophic effects and/or prey switching. To remove these problems we will seek specific conservative biomarkers such as essential amino acids or fatty acids that carry isotope ratios unmodified by metabolism. Amino acids labeled with 15N and 13C will be used to follow transamination and carbon relocation during metabolic processes in the seals at the Alaska SeaLife Center. Specific fatty acid isolation and determination of suitability as habitat biomarkers will follow in years two and three of the project.

INTRODUCTION

Stable isotope ratios have become an essential tool in the study of living organisms and their physiology. The hazards of handling radioisotopes and severe protocol requirements when using live organisms have resulted in a steadily increasing shift to the use of stable isotopes as tracers for both human and animal subjects. Some uses, such as the detection of *Helicobacter pylori* infections in ulcer patients, are now routine and bringing stable isotope analysis to many hospitals as a standard method. In contrast with the employment of natural abundance techniques in the marine environment, most physiology experiments employ compounds enriched with ^{13}C or ^{15}N to enhance detectability and to follow the transfers to different metabolites within the organism. Improved lower limits of detectability and smaller sample size requirements now allow the use of stable isotopes where only radioisotopes would have worked in the past.

This proposal describes experiments to be undertaken at the Alaska SeaLife Center (ASLC) and at the University of Alaska Fairbanks (UAF) to provide calibration and more detailed information on stable isotope transfers and fractionation in marine mammals (and perhaps sea birds in the future). This will enable better interpretation of natural abundance isotope data acquired in Prince William Sound and the adjacent Gulf of Alaska. Coordination with the work of Michael Castellini, who is conducting feeding experiments and dietary studies at ASLC, will lead to a thorough integration of efforts and optimization of the use of animal subjects in all years of the study. Year 1 will consist of the refinement of analytical techniques isolating amino acids and testing for the presence of essential amino acids in harbor seals at ASLC. Succeeding years will focus on the search for biomarkers useful in identification of specific habitat usage and as indicators of the assimilation of various species of forage fishes.

Over the past two decades, isotope ratio analysis has emerged as a powerful tool in ecosystem research, both on the process scale and as a validation technique for large-scale ecosystem models (Michener and Schell, 1994). In relevant applications to this study, Saupe et al. (1989) and Schell et al. (1989) described a geographic gradient in isotope ratios in biota across the Alaskan Beaufort Sea and the Bering–Chukchi seas and showed that this gradient could be applied to describing bowhead whale natural history. The isotopic gradient arises from the primary producers in the ecosystem and is passed up food chains to label consumers up to the top predators. Within each biome, there is reasonable fidelity to the ^{13}C observed in the primary producers and a predictable increase in the ^{15}N with each known increase in trophic level. However, among individuals of each taxon analyzed there are often large ranges in values, especially in the carbon isotope ratios.

A fundamental assumption in the employment of isotope ratios as natural tracers is that the amount of isotopic fractionation in the process of metabolizing food is known during the incorporation of assimilated components into the consumer. For marine mammals, these data are scarce and most of the ongoing work is based on the findings derived from terrestrial bird and mammal studies. The accurate interpretation of isotope ratio data on food webs and marine mammals depends completely on knowledge of fractionation effects arising from dietary sufficiency and composition. To date, we do not have this knowledge because it has become evident that there exist marked geographic gradients in isotope ratios in Prince William Sound and the Gulf of Alaska. This project is thus aimed at the goal of identifying specific biomarker molecules and acquiring accurate isotope fractionation data on harbor seals through controlled feeding and laboratory experiments. This project will be thoroughly integrated with ongoing

research on harbor seals at the ASLC and will be complementary to the physiological research projects in progress.

NEED FOR THE PROJECT

A. Statement of Problem

Harbor seals were undergoing an unexplained decline in numbers before the oil spill and the decline was further accelerated by the disaster. Since that time the population has not recovered and is still at a low level, although now perhaps finally stabilized. No definitive cause and effect relationships have been found for the decline or failure to recover. It is becoming increasingly evident, however, that change in the marine environment in the past two decades has altered the carrying capacity downward in the northern Gulf of Alaska and that the effects are being felt to the top of the food chain. Carbon isotope ratios in biota of the northern Pacific Ocean appear to have been declining for nearly twenty years (Schell, in preparation) and imply that a major decrease in productivity has occurred. Isotope ratios from wild seals also show changes over time in the isotope ratios but the interpretation requires knowledge of both the fractionation that occurs during assimilation and the natural variations arising from migrational movements. If one or more essential amino acids can be identified in the diet of seals, these would allow a conservative tracer independent of isotope fractionation effects. There are almost no data regarding marine mammals on this subject and none on harbor seals. This study will undertake to follow both the "whole animal" carbon and nitrogen isotopic fractionation and the determination of specific biomarkers arising from diet that would allow clearer insight into dietary dependencies.

B. Rationale/Link to Restoration

Carbon isotope ratios serve as conservative tracers of energy supply between trophic levels (phytoplankton to zooplankton to fishes to top consumers). Seals, cetaceans, birds, etc. acquire the isotope ratios in proportion to the amount of food derived from each differing source. This, in turn, is reflected in the composition of body tissues and in keratinous tissues (claws, feathers, baleen, whiskers) as a temporal record when multiple sources of food are consumed over time and space. This allows the discerning of important habitats and food resources in animals such as harbor seals that seasonally migrate or undergo periods of hyper- and hypotrophy. Little is known, however, of the internal fractionation of isotopes that occurs in mammals during fasting and/or extended periods of suboptimal diets. The planned experiments on the effects of differing diets on captive harbor seals to be conducted at the ASLC will provide an ideal opportunity to enhance the physiological data gained by investigating the efficiency of amino acid transfers in diets and the presence of essential amino acids in pinnipeds.

Nitrogen isotope ratios reflect both the food sources and the trophic status of that animal. As nitrogen in food is consumed and assimilated by a consumer, the heavy isotope is enriched by approximately 3‰, with accompanying loss of the lighter isotope through excretion. The enrichment occurs with each trophic step and thus allows the construction of conceptual models and food webs and the assignment of relative trophic status to species for which dietary data are sparse. Hobson and Welch (1992) used isotope ratios to describe the trophic relationships of birds and mammals to the available prey species in the Canadian Arctic. Further extension to the

benthos by Dunton et al. (1991) and to fishes (Vinette, 1992) has confirmed that the isotopic trends are evident across the entire food web. As fasting or starvation occurs, nitrogen isotopes may be fractionated during transamination reactions, leading to overall shifts in the average isotope ratios of the whole animal. Best and Schell (1996) observed, for example, that ^{15}N enrichment in southern right whales was evident during the winter breeding season in South African waters, though carbon isotope ratios revealed that very little feeding occurred. Detailed interpretation of data from samples taken from wild seals requires that these effects be known.

C. Location

The research effort will be conducted at the Alaska SeaLife Center and the University of Alaska Fairbanks. The instrumental analyses such as HPLC and gas chromatography–mass spectrometry will initially be undertaken at UAF on samples collected during the dietary studies and sampling at ASLC by Dr. Castellini's group. In years 2 and 3 more of the effort will be shifted to ASLC as detailed dietary experiments are conducted.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Much of the research will be conducted at the Alaska SeaLife Center. The Principal Investigator anticipates both community interaction and explanation of the research approach and usefulness at the site.

PROJECT DESIGN

A. Objectives

The null hypotheses to be tested in 1998–1999 and succeeding years are as follows:

1. The isotope ratios of harbor seals accurately reflect diet under all conditions. Increased fractionation does not occur during periods of fasting or suboptimal feeding and does not affect either carbon or nitrogen isotope ratios in harbor seals.

2. There are no essential amino acids in harbor seals and their prey that can act as conservative markers of specific habitats of food sources or of specific prey species.

The objectives of this study are divided into three elements:

1. Year 1 will consist of developing methods and protocols for the isolation of metabolites from harbor seal blood and tissue samples to be employed during the following controlled diet studies. The Institute of Marine Science has purchased a new GC-IRMS (gas chromatograph–isotope ratio mass spectrometer) that will be used to determine isotope ratios in the individual amino acids isolated from serum samples. These amino acids will be separated by high performance liquid chromatography using semi-preparative columns and inorganic buffers. Testing for essential amino acids in harbor seals will be initiated using blood samples acquired from seals being used by Michael Castellini for food assimilation efficiency studies. By feeding ^{15}N and ^{13}C-labeled glycine to the seals prior to blood sample collection, it will be

evident if the label has been transaminated to all amino acids and to what extent. If some amino acids remain unlabeled, the corresponding labeled amino acid will be administered to see if transamination occurs in the reverse direction.

2. The second component will be a study of the effects of suboptimal versus optimal diet on the fractionation of carbon and nitrogen isotopes in harbor seals. Diets of known amount and composition (isotopic and energetic) will be fed to the seals at ASLC and blood protein amino acids will be monitored for composition and isotope ratios. This research will be closely coordinated with studies of controlled diet/assimilation efficiencies in harbor seals by Castellini so that minimal animal handling and sampling will be necessary.

3. The third component will be to determine source prey for isotopically distinct fatty acids or other metabolites. The identification of specific fatty acids that carry a conservative signal to top consumers (birds, cetaceans, fissipeds) would yield an extraordinarily valuable tool to follow food web transfers or to identify specific habitat importance. This will be accomplished by the analysis of lipids in prey species from locations around the study areas and from seals. Many of the prey species samples are already archived and analysis can begin very soon.

B. Methods

Isotopic Analysis of Blood Protein Amino Acids

The proteins in blood serum samples from captive harbor seals and muscle protein from Native-harvested seals will be separated from inorganic components via ion retardation columns, and the isolated protein hydrolyzed to free amino acids. Multiple procedures to optimize amino acid preservation will be employed, such as acid and basic hydrolysis and through the use of proteolytic enzymes. Once isolated, the free amino acids will be separated by HPLC (high performance liquid chromatography) and the aliquots with individual amino acids will be taken to dryness. These samples will then be run on an elemental analyzer coupled to the isotope ratio mass spectrometer. The nitrogen and carbon dioxide liberated in the elemental analyzer will be separated by gas chromatography and run individually in the IRMS. By either orally or intravenously dosing a seal with ^{13}C or ^{15}N-labeled glycine, the appearance of the label will be noted over time in the amino acid spectrum. Those amino acids remaining free of the label will be identified as probable essential amino acids derived solely from diet. Mobilization and isotopic fractionation of these amino acids will be tested further in reverse dietary studies wherein the labeled amino acid will be infused and the rate of transamination followed in feeding and fasting seals.

Isotope Fractionation During Fasting and Suboptimal Diets

Many marine mammals undergo periods of fasting or suboptimal diets such as during molt or reproduction. Nothing is known regarding the effects of these periods on the fractionation of either carbon or nitrogen isotopes in harbor seal tissues. The amino acid threonine, for example, has been shown to become very isotopically depleted in ^{15}N during starvation, with lesser effects on glycine and serine (Hare et al., 1991). In coordination with studies of dietary effects on blood hormones or other work requiring harbor seal blood samples at ASLC, we will analyze aliquots as described above for shifts in the isotope ratios. Mobilization of amino acids during fasting can be tested via isotope dilution of labeled amino acids given intravenously at the start of the fast. These experiments will be conducted in the second year of the experiment and will be carefully

planned to minimize animal handling and for maximum synergy with other researchers. Although we plan to coordinate our sampling with that of Dr. Castellini, all procedures will be approved by the ASLC scientific committee and conducted as required by the IACUC (Institutional Animal Care and Use Committee) of the University of Alaska Fairbanks and ASLC.

Sources of Essential Amino Acids in the Diets of Harbor Seals
The identification of specific metabolites, specifically fatty acids and amino acids, in the tissues of harbor seals (Iverson et al., in press) will be followed by a survey of potential prey species to identify probable sources. Fatty acids will be isolated using the procedures of Iverson et al. (1993) and run from the gas chromatograph directly into the microcombustion unit of the preparatory system and then into the mass spectrometer. This will yield both a fatty acid spectrum and the isotope ratios for each component. The combination of chemical markers may provide a powerful tool for the identification of specific prey or habitat usage. The APEX program currently supported by EVOS will be a source of samples, as will other opportunistic cruises in the spill and control areas. Herring, sand lance, pollock and capelin will be special targets, given their importance in the food chains of Prince William Sound.

In order to strengthen the expertise in biochemistry and to provide a comprehensive internal review of planned experiments, the following steps will be implemented:

Selection of Ph.D. candidate to undertake primary sampling and analytical work: synthesis of data and dissertation preparation under supervision of D.M. Schell and the graduate study committee
The Principal Investigator has accepted ***Liying Zhao*** as a Ph.D. candidate to undertake the experimentation on this project. Ms. Zhao has an exceptionally strong background in chemistry and has excellent grades and recommendations from her professors. Her past curriculum has been heavily weighted to organic and analytical chemistry and she has completed introductory study in biochemistry. She is planning on continuing her courses in biochemistry during this study.

Graduate study committee for review of experimental procedures and results
In response to the request for additional biochemistry, nutrition and metabolism expertise, a graduate advisory committee has been formed for Ms. Zhao that has a strong emphasis on these disciplines.

Donald Schell Professor of Marine Science, as PI, he will be committee chair and will provide the primary expertise in stable isotope usage and interpretation of isotope ratio data.

The following UAF faculty have agreed to comprise the remainder of the graduate committee and to assist in experimental design and review of biochemical data:

Michael Castellini Professor of Marine Science, has a background in biochemistry and is currently involved in studies of marine mammal nutrition at the ASLC.

Lawrence Duffy Professor of Biochemistry and Chemistry, is the current Head of the Department of Chemistry and Biochemistry.

Susan Henrichs	Professor of Marine Science, is a chemist specializing in the microbial biochemistry of amino acids in marine environments.
Bruce Finney	Associate Professor of Marine Science, is experienced with the environmental aspects of ocean chemistry and stable isotope methodology.

As the graduate advisory committee for Ms. Zhao, the above committee will aid in experimental design and review of protocols as well as assist with whatever difficulties may arise with the analytical aspects of the study.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Michael Castellini is concurrently submitting a renewal proposal (99341) for related work on blood hormones and food assimilation efficiency studies at the Alaska SeaLife Center. This project will be completely coordinated with his work to optimize sampling and mutual assistance.

SCHEDULE

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

October–February:	Analysis of standard amino acid samples from seal tissues Protocol development for fatty acid analysis
March–July:	Establish methodology and protocols for the isolation and identification of amino acids from harbor seal blood proteins
March–April:	Begin isotopically labeled feeding experiments
April–December:	Analytical work, continue feeding experiments

B. Project Milestones and Endpoints

The following are additional specific goals beyond FY 99:

FY 00–01

November–August:	Isolate amino acids from prey species and establish isotope ratios in any essential amino acids identified; prepare annual report on FY 99 (and prior) work
August–December:	Conduct feeding experiments, prepare draft manuscripts

FY 01

October–May:	Complete experiments; synthesize data and identify gaps; prepare manuscripts and submit draft final report.
June–October:	Complete manuscripts and final report

C. Completion Date

This project will be completed by September 2001. Manuscript preparation and submissions may continue past the nominal completion date.

PUBLICATIONS AND REPORTS

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

Annual Reports: These reports will detail progress and preliminary findings and notable achievements. These are anticipated for the ends of FY 99 and FY 00.

Final Report: A final report will be provided. Technical results in this report will be shared with EVOS collaborators and assistance provided as opportune during the experiments. Preliminary exchange of findings will be conducted with EVOS investigators and the scientific community via professional meetings and informal communications.

Peer-reviewed publications: Over the course of this study peer-reviewed publications will be generated for the open literature based on the scientific findings. These publications will be generated by the PI and graduate students as first author publications when the primary focus is on the findings produced by the isotopic techniques or as second author publications when the isotope work is a minor part of other scientific results resulting from feeding experiments conducted by colleagues.

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

Public lectures: Interaction with the public will arise through formal and informal presentation of results as part of ongoing public participation in the work at ASLC. Synthesis meetings designed to explain the findings will be presented at meetings coordinated by ASLC or EVOS and open to the public. Informal presentation of results will occur through interaction with interested members of the public, press and scientific community. Classroom instruction will also involve integration of findings into the presentation of educational material.

PROFESSIONAL CONFERENCES

The results of this project will be communicated at appropriate meetings. The biennial meeting of the Society for Marine Mammalogy or the American Society for Limnology and Oceanography is a typical forum for this type of presentation, as are specific workshops and meetings emphasizing application of isotope techniques to biological problems.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Resources and Services—This study focuses on harbor seals in Prince William Sound and requires the facilities for animal holding at the Alaska SeaLife Center. Insofar as the PI is requesting no seal handling or holding support in this project it is essential that it be closely coordinated with ongoing projects that can provide subsamples of blood or biopsies for analysis. To this end, the PI has made the project outline and goals available to Dr. Castellini and presumes a very close interaction with his program. It is expected that the Ph.D. student

supported by this project will be integrated with Dr. Castellini's project and will share time and assistance with his project team. We seek to provide a set of useful biomarker tools that will aid future field efforts in Prince William Sound and can be expanded to other injured species. Although the major effort is concerned with harbor seals, other marine mammal tissues will be analyzed if available to provide context and comparable data. Sea lions held at ASLC will also be sampled if conditions allow and if funds are derived from other sources. To simplify animal use and care permitting, we will coordinate all projects' permitting closely under the direction of Dr. Castellini, based on mutual interests and animal handling requirements.

PROPOSED PRINCIPAL INVESTIGATOR

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4, 98
Approved TC 8-13-98

1999 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 – September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$0.0
Travel		$0.0
Contractual		$99.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$99.0
General Administration		$6.9
Project Total	$0.0	$105.9
Full-time Equivalents (FTE)		1.5
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 2000	Estimated FY 2001	Estimated FY 2002
$95.0	$95.0	$0.0

Dollar amounts are shown in thousands of dollars.

Comments:

TOTAL PROJECT COST:

$105.9
+ 4.3 ASLC Bench Fees
$110.2

FY 99

Prepared: Prepared: 7/9/98

Project Number: 99371
Project Title: Effects of Harbor Seal Metabolism on Stable Isotope Radio Tracers
Name: University of Alaska Fairbanks
Agency: ADF&G

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1999 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 – September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999					
Personnel		$59.9					
Travel		$6.5					
Contractual		$10.4					
Commodities		$2.4					
Equipment			LONG RANGE FUNDING REQUIREMENTS				
Subtotal		$79.2		Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Indirect		$19.8					
Project Total		$99.0		$95.0	$95.0		
Full-time Equivalents (FTE)		1.5					
	Dollar amounts are shown in thousands of dollars.						
Other Resources							

Comments:

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

Personnel costs for Ph.D. student include two semesters of resident tuition ($2,916).

FY 99

Project Number: 99371
Project Title: Effects of Harbor Seal Metabolism on Stable Isotope Radio Tracers
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

1999 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 – September 30, 1999

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 1999
	Schell, D.	Principal Investigator/Professor	2.0	12.4		24.8
	Haubenstock, N.	Technician	3.0	5.2		15.6
	Barnett, B.	Research Associate	0.5	4.5		2.3
	TBN	Ph.D. Student	12.0	1.4		16.8
		Adjustment to recognize rounding				0.4
		Subtotal	17.5	23.5	0.0	
					Personnel Total	$59.9

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 1999
	Fairbanks to Anchorage – EVOS meeting	0.3	1	5	0.1	0.8
	Fairbanks to Seward – research at Alaska SeaLife Center	0.4	2	20	0.1	2.8
	Fairbanks to Lower 48 – presenters at ASLO meeting or Society for Marine Mammalogy meeting	0.7	2	8	0.1	2.2
	Adjustment to recognize rounding					0.7
					Travel Total	$6.5

FY 99

Project Number: 99371
Project Title: Effects of Harbor Seal Metabolism on Stable Isotope Radio Tracers
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 7/9/98

1999 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 – September 30, 1999

Contractual Costs:	Proposed FY 1999
Description	
Mass spectrometry (535 samples @ $18/sample)	9.6
Publication, page charges	0.6
Communications, photocopying	0.2
Contractual Total	$10.4

Commodities Costs:	Proposed FY 1999
Description	
HPLC supplies, chemicals, expendables	2.2
Computer supplies	0.2
Commodities Total	$2.4

FY 99

Project Number: 99371
Project Title: Effects of Harbor Seal Metabolism on Stable Isotope Radio Tracers
Name: University of Alaska Fairbanks

FORM 4B
Contractual & Commodities DETAIL

Prepared: 7/9/98

1999 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 – September 30, 1999

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

Existing Equipment Usage:	Number of Units	
Description		

FY 99

Project Number: 99371
Project Title: Effects of Harbor Seal Metabolism on Stable Isotope Radio Tracers
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared: 7/9/98

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

Budget Category:	Authorized FY 1998	Proposed FY 1999	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$0.0						
Travel		$0.0						
Contractual		$4.0						
Commodities		$0.0						
Equipment		$0.0						
Subtotal		$4.0		Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
General Administration		$0.3						
Project Total		$4.3						
Full-time Equivalents (FTE)		0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

FY 99

Project Number: 99371
Project Title: Bench Fees: Effects of Harbor Seal Metabolism on Stable Isotope Ratio Tracers
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Approved TC 8-13-98

Effect of Herring Egg Distribution and Ecology on Year-Class Strength and Adult Distribution

Project Number:	99375
Restoration Category:	Research
Proposer:	E. Brown, B. Norcross/UAF
Lead Trustee Agency:	ADFG
Cooperating Agencies:	None
Alaska SeaLife Center:	No
New or Continued:	New
Duration:	1st yr. 2 yr. project
Cost FY 99:	$76.5
Cost FY 2000:	$48.2
Cost FY 01:	$0.0
Cost FY 02:	$0.0
Geographic Area:	Prince William Sound
Injured Resource/Service:	Herring

ABSTRACT

This project will examine the effect of Pacific herring egg distribution and abundance as well as oceanographic processes on year-class strength and adult distribution. Existing data will be used in the analysis. The findings of this study will aid in understanding stock structure and population dynamics of herring in Prince William Sound. This information will facilitate area-specific targeting of catches and provide scientific documentation of unpublished fishery data.

INTRODUCTION

The overall objective of this project is to refine our understanding of Pacific herring (*Clupea pallasi*) population structure and trends in Prince William Sound (PWS) by examining current and historic data on fish distribution within an ecological context. The components of this project include:

1. Defining temporal trends of early life history (eggs) distribution.

2. Describing the relationship between that distribution and the oceanography of PWS.

3. Analyzing the impact of that distribution on population structure and abundance 3–4 years later.

If this approach produces significant results, it can be continued in FY00 to include biological indices such as size-at-age, and for recent years, energetic content, isotopic values, fatty acid signatures, growth rates, feeding rates, and others. The second-year analysis would strengthen any conclusions about population structure and resulting population dynamics.

This proposal addresses the problem statement entitled, "Herring Population Ecology and Biomass" on page 10 of the EVOS "Invitation to Submit Restoration Proposals for Federal Fiscal Year 1999."

It is important, at this stage, to define terms used in this proposal:

Population	A genetically unique and reproductively isolated group of individuals; i.e., the size of a shared gene pool (Sinclair 1988).
Sub- or Meta-population	A group of individuals that may not be genetically unique but is identified by unique distributions in time and space. Recruitment processes specific to the sub-population act in maintaining its separateness. Sub-population may be equivalent to the fisheries term "stock" (defined as a management unit or stratum).

Populations or sub-populations of Pacific herring can be defined by their unique distributions at each life stage, although overlap among populations does occur (Sinclair 1988). The spatial dimensions and characteristics of the area encompassing a unique population fundamentally affect population size and variability. Current SEA research (97320-T; Stokesbury et al., 1997) revealed that although there is some overlap in spawning, juvenile nursery, adult summer feeding, and both juvenile and adult overwintering distributions in PWS, the distributions are largely distinct. The implications for population structures nested within these defined distributions are unclear. Iles and Sinclair (1982) and Sinclair (1988) described unique areas used by different life stages of Atlantic herring. Others have defined herring stocks as a function of distribution of the life stages over time (Carlson 1980). Stocker (1993) described two types of herring populations in British Columbia: major migratory stocks and smaller resident stocks, usually found at the heads of bays or inlets.

In PWS, "milt sightings" have been recorded in distinct regions since 1973 (Brady 1987). Major spawning has occurred on beaches in central (Montague and Naked Islands), northern (North Shore), northeastern, and southeastern PWS (Figure 1; Table 1; Biggs et al. 1992), while minor spawnings have been observed in western and southwestern portions of the sound (SEA, unpublished data). The areas with the most consistent annual spawn are Montague Island and northeastern PWS (Table 1). The extent of major spawning has varied from 21 to 268 km since 1973. Spatial variability in location of spawning and egg density is highly variable between years (Figures 2 and 3). Current SEA aerial and vessel surveys reveal minor spawnings in PWS that appear to be due to small local adult groups. These minor spawnings are separate from the major spawning recorded by the Alaska Department of Fish and Game and are later in the year, but could have large ramifications in terms of recruitment, herring availability as forage, and population stability. The recurring use of the major spawning areas, the distances between these areas, and the differences in spawn timing compared with the minor spawning areas all point to the possibility of multiple stocks or sub-populations within PWS.

Tagging studies on Pacific herring in BC reveal that discrete spawning populations can occur on the scale of approximately half of PWS (Hourston 1982; Stevenson 1955) with a range in homing between 64 and 87% (Hourston 1982). Wheeler and Winters (1984) report homing fidelity of spawning Atlantic herring at 90%.

Other tools to separate stocks (genetics using electrophoresis and mitochondrial DNA, morphology and meristics) have provided information valuable for discerning differences on large scales (e.g., BC to PWS) but generally fail when used in trying to distinguish within an area the size of PWS (Schweigert 1981 and 1990; Meng and Stocker 1984; Grant and Utter 1984; Schweigert and Withler 1990; Safford and Booke 1992). These techniques also provide little information about movement and recruitment dynamics. Genetic homogeneity, probably due to larval drift and dispersion (Hay and McCarter 1991), prevents discernment of the stocks at the scale needed to assess movement or the occurrence of sub-populations.

It appears, based on data from current and past studies, that Pacific herring in PWS compose a genetically homogeneous population (J. Seeb, ADFG, personal communication). Evidence of two relatively separate sub-populations based on the existence of 1) two major spawning areas (northeast PWS and northern Montague Island; Figure 1), 2) two main overwintering adult aggregations (Port Gravina and Montague Strait) (Biggs et al. 1992; ADFG unpublished data), and 3) consistent adult size-at-age differences between the groups (eastern versus central PWS). A mechanism explaining genetic homogeneity is mixing at the larval stage. A mechanism explaining the maintenance of separate sub-populations occurs once larvae have recruited to near-shore nursery bays. If juvenile herring remain separated in these nursery bays until large enough to join adult schools, then recruitment to each sub-population may be specific to the associated region of the sound (i.e., east-side nursery area juveniles recruit to the Port Gravina/northeast side adults). This implies that there is fidelity of adult herring to major spawning regions within PWS. Evidence from current studies by SEA indicate that juvenile herring age 1.5 disappear from nursery bays in late summer (July and August) and mix with adult schools (based on age composition of catches; Stokesbury et al. 1997) prior to the overwintering period. Therefore, the location of nursery bays becomes important in the determination of population structure. The location of nursery bays may depend on the location of natal habitats and on larval drift trajectories. The relative abundance of juveniles within the nursery bays may in turn depend on density of eggs at associated natal habitats. If conditions within nursery bays

vary, producing differences in juvenile herring growth and survival, than changes in distribution of herring among nursery bays has an impact on overall recruitment. Therefore, changes in the distribution and density of spawn could affect overall population structure by impacting larval drift and the resulting location and relative abundance of juvenile herring.

Since 1995, our knowledge and understanding of herring ecology in PWS and the Outer Kenai have improved considerably because of the work by SEA (Cooney 1997). In addition, great strides have been made in understanding the oceanography within PWS, along with the variability of the food base in space and time. Many of the components of ocean circulation as well as primary and secondary production have been successfully modeled. Also, in recent years, progress has been made toward understanding the effects of climate and oceanography on the population dynamics of Pacific herring (Schweigert, 1995; Zebdi and Collie, 1995). The current project will build upon that knowledge by examining present and historic distributions of herring eggs within the context of environmental conditions. The project is cost-effective since it is largely an analysis of existing data which, to a large degree, have never been published. This is an important step in the synthesis of ecological data for this key forage species.

The main working hypothesis for this project is:

> Adult Pacific herring year-class strength and distribution is dependent on the initial distribution and density of herring embryos, modulated by ocean conditions during the first two years of life.

A second companion proposal entitled, "Distribution and Ecology of Forage Fish and Effects on Herring Year-Class Strength," addresses an expanded version of the hypothesis stated above:

> Adult Pacific herring year-class strength and distribution are dependent upon the initial distribution and density of herring embryos, modulated by ocean conditions during the first two years of life, *and highly correlated with the resulting distribution and relative abundance of juvenile fish schools observed in the summer.*

The companion proposal deals with the second part of the hypothesis that involves the link between juvenile herring distribution, oceanography and adult population structure and distribution.

NEED FOR THE PROJECT

A. Statement of Problem

Pacific herring are a key species in the marine ecosystem of Prince William Sound. The health of the apex predator community may depend on the magnitude of herring recruitment and the condition of individual fish, since herring are the key forage fish in the sound (Lew Haldorson, UAF, personal communication). The decline of the PWS herring population (Brown et al. 1996a and 1996b) has had serious and significant negative impacts on commercial fisheries, subsistence food-harvest patterns, and distribution of wildlife in areas now devoid of herring spawning and feeding. The effects of these impacts on oil-injured predators of herring are only beginning to be understood by other EVOS-funded researchers. Nine years after the spill, Pacific herring are still

listed by the EVOS Trustee Council as "injured and not recovering." Direct restoration of this species is not practical; however, understanding and monitoring its recovery is important in order to improve stock assessment for management of commercial fisheries. Recovery can only take place via successful recruitment of juvenile herring to the adult population in PWS.

B. Rationale/Link to Restoration

The research completed under this project combined with historic data from ADFG and current information from the SEA project will help us refine models describing processes controlling and regulating herring recruitment. This information will help us to better understand the dynamics of the recovery of this species.

C. Location

The data for the work included in the proposal are limited to Prince William Sound.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

We will utilize the results of the TEK project 98320-T supplement entitled, "Documenting Forage Fish Natural History through Local and Traditional Ecological Knowledge." Specifically, the findings of this project will be compared with observations from resource users over the past 50 years. The TEK project documents observations of individuals which coincide with observations herring researchers have recorded in recent years. The Principal Investigator, Evelyn Brown, is also the Principal Investigator for the TEK project and will assist with closeout and publication preparation. The findings of this study will be shared with interested participants in the herring TEK project.

PROJECT DESIGN

A. Objectives

The research questions followed by the specific objectives are:

FY 99
How does herring egg density and year-class strength 3–4 years later vary geographically over time?

1. Determine temporal and spatial variability of herring spawn and year-class strength.

2. Identify natural groupings of the data and areas with greater variability.

Is there coherence in the trends of the two life stages?

3. Determine the correlation between the magnitude of spawn and the year-class strength.

How are egg and adult distributions compartmentalized oceanographically in PWS?

4. Define oceanographic regions and their associated hydrography within PWS.

How do oceanographic trends within the regions modify the coherence among the trends of herring egg and adult distribution and abundance?

5. Determine the relationships and interactions among the regional magnitude of spawn, oceanographic conditions, and year-class strength.

6. Examine areas of greater variability or similarity in the biological indices by comparing the oceanography.

FY 00
Is there biological evidence consistent with the ecological evidence for regionalization or the formation of sub-populations of herring in PWS?

1. Compile biological indices (energetics, growth, diet, etc.) stratified by region for juvenile and adult herring in PWS.

2. Determine how biological indices interact with oceanographic variables and affect year-class strength.

B. Methods

Fish Data
Historic information on miles of spawn, adult herring biomass, age structure, and distributions are readily available from ADFG for most years since 1973. These data will provide at least 20 years' information for comparison in the statistical models. As a proxy for egg density or abundance, we will use "mile-days" of milt (converted to km) which represents the cumulative spawn over a number of days in a given area.

Oceanographic Data
The oceanographic data come from multiple sources and are available over a range of time and space scales. For the purposes of this study, we will focus on data for the time period in which eggs are laid (April) until the time larvae recruit to near-shore nursery bays (July). This is the time period in which partitioning of the population occurs if it happens at all. From 1993 on, satellite images are available in a variety of formats, each providing different information about PWS and the adjacent Gulf of Alaska. Advanced Very High Radiation Radiometer (AVHRR) images will indicate eddies and currents. Sea-Viewing Wide Field-of-View Sensor (SeaWiFS) images provide ocean color, and Synthetic Aperture Radar (SAR) images show ocean front structure under cloud cover. These three images together, along with a subset of hydrographic data within regions of interest, may indicate structure that affects partitioning of the herring population (during larval drift and rearing in nursery areas). Kevin Engle, a satellite imagery specialist at the UAF Geophysical Institute, will compile and summarize these images for the project. For years prior to 1993, oceanographers at the Prince William Sound Science Center have compiled a set of historic hydrographic and meteorological data for the region. By subsampling this dataset within the same regions subsampled for the recent data series,

hydrographic data should be comparable between the two time periods (post- and pre-1993). Therefore, we should be able to look, retrospectively, at the same conditions that may act in partitioning. We will most likely do this for a subset of the 20 years since there are holes in the historic dataset. We will subcontract for the hiring of an oceanographer from PWSSC for help with the interpretation and analysis.

Statistical Analysis

A variety of graphic and statistical methods will be applied in this analysis. The distribution data (eggs and adult population) vary in time and space. The simplest way to visualize this variability is to draw a circle that encompasses all historic spawning and adult spawner staging areas, stretch that circle out in a line, and plot the abundance information on the line. In this way, segments of the line represent regions. Although this linear scale is arbitrary (not a true continuous variable like time), statistical analyses can be performed between segments of the line which represent independent events (individual spawning areas). By looking at each year individually and at all years pooled graphically, we will use the data to identify clusters (i.e., regions). The initial graphical examination of the data will indicate trends that will be obvious and will guide the analysis itself.

The first step, once extended graphical analysis is complete, will be to run a cross-correlation (time-series method; Rothschild et al. 1996) between the predictor variable of spawn abundance versus the response variable year-class strength within each region. Coherence between the trends may be highly variable, but that information will tell us which regions vary more and will guide the link to the environment. In performing the time-series, instances of auto-correlation between areas and years may become evident. The models selected from analysis should be able to deal with this problem.

Checking our data for violation of statistical model assumptions will be an important step. We have chosen to use general additive models (GAM), categorized as non-parametric regression, since that approach does not require linearity or normality. However, uniform variance is an assumption. Therefore, we will examine the residuals of the variables among regions. If there are serious departures from uniform variance, transformations may have to be performed. If the relationships between the predictor and response variables are largely linear (or can be linearized via transformations), we can perform a simple analysis of variance (ANOVA) and multiple regression to identify the important parameters. However, it is anticipated that many of the relationships will be non-linear and that oceanographic variables will be non-normal. The choice for a GAM is therefore clear.

Once we have a thorough understanding of the data and variability, we can proceed with the GAM analysis. This step involves compartmentalizing all the variables, biological and physical, within the regions identified. The general model takes the form:

$$\ln(R) = \alpha + \sum_{j=1}^{p} f(E_j) + g(S) + \varepsilon$$

where R is the year-class strength, α is an intercept parameter, p is the number of environmental predictor variables, $f(E_j)$ a function of the environment predictor variables (continuous or class; linear or non-linear forms), and $g(S)$ is the function of egg abundance ("mile-days" of spawn)

(modified from Hastie and Tibshirani 1990; Jacobson and MacCall 1995; Swartzman et al. 1992). Multiple iterations of this model will be run with some variables falling out and others emphasized.

It is probable that there will be regions of high variability (i.e., major but inconsistent spawning areas). It could be that those areas are at the edges of oceanographic regions and that the variability is due to "phase" shifts in the environment. We will explore trends in those regions more thoroughly by adding class variables to the analysis to account for significant interannual shifts in conditions. There may also be indications for pooling of regions with similar trends in population dynamics and ocean conditions.

Adding Biological Indices – FY 00

Biological indices such as size-at-age of herring can easily be incorporated with the approach suggested in this proposal. Regional herring age, weight, length, and age composition data are available for at least 20 of the past 25 years in PWS. In recent years, regional information on adult herring energetics, isotope composition, and fatty acid signatures have also become available. It is possible that historic otolith and scale patterns may become available if currently proposed research is funded (Peter Hagen and John Wilcock, ADFG, personal communication). Using regions delineated by the FY99 analysis, the biological indices can be built into the GAM relatively easily. Other statistical tools such as ANOVAs (given normal distribution and independence of indices), non-parametric tests such as the Mantel test (Legendre and Fortin 1989), or clustering can be explored. The biological indices may provide hard evidence of any population structure that exists. Defining population structure is critical to understanding the population dynamics of herring in PWS. The decision to proceed with this analysis will largely depend on significant findings in the previous year.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The University of Alaska Fairbanks is the main entity included in this proposal. We will contract with the prince William Sound Science Center for an oceanographer to help with the compilation of oceanographic data and assist in interpretation. We will use historic data provided by the Alaska Department of Fish and Game and will share all findings with that agency.

If this project is continued for a second year, it is anticipated that the role ADFG will play in the analysis, interpretation, and report completion will increase dramatically.

SCHEDULE

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

November 30: Digitize historic spawn and adult herring distribution information within a geographic context; plot distributions for each year as oscillations along an axis representing linear space. Examine plots for each year thoroughly using both 3- and 4-year lags; identify natural regions (groupings of points) along the linear space scale; identify areas (regions) along the curve with greater variability.

December 31:	Within each region complete a cross correlation (time-series analysis) to determine what, if any, relationship exists between spawn and year-class strength within a given area. Within each region determine the mean and variance of each variable; run a residual analysis to look for violations of uniform variability.
February 28:	Acquire an appropriate set of oceanographic data matching time and space scales of the newly created regions; oceanographic variables can be set up as continuous (i.e., temperature anomalies, SST) or class (high flow vs. low flow) predictor variables for the analysis. Set up a general additive model (GAM) with the response variable being year-class strength and several predictor variables including spawn density (miles of milt), a class variable for regions and the oceanographic variables.
May 31:	Determine statistically significant relationships; proceed with further analysis of regional differences as warranted using only the variables showing significant relationships. One result may be pooling of regions with similar physical and biological dynamics, correlation coefficients, and temporal trends.
August 31:	Finalize publication for project.

B. Project Milestones and Endpoints

FY 99

November 30:	Documentation of variability of herring spawn and year-class strength (Objective 1 and 2) completed
December 31:	Finish correlation between spawn and year-class strength (Objective 3)
February 28:	Oceanographic regions defined with accompanying data sets (Objective 4) Initial run of GAM done (Objective 5)
March 24:	Attend EVOS symposium
May 31:	Statistical analysis completed (Objectives 5 and 6)
August 31:	Publication finalized
September:	Attend AFS meeting

FY 00

October 27–30:	Attend Lowell Wakefield Symposium
November 30:	Compile the biological indices stratified by the regions defined in FY99 (Objective 1)
February 28:	Include the indices in the GAM model. Explore other statistical tools for determining significant and temporally consistent relationships between the biological and physical predictor variables, including their interactions. (Objective 2)
May 31:	Complete analysis of the data and compile the results in a publication endpoint
August 31:	Second publication completed

C. Completion Date

September 30, 2000

PUBLICATIONS AND REPORTS

The final report for this project will be in the form of publication reprints. Documentation of all the findings will be available to EVOS as attached appendices. This report will also be included as a Ph.D. dissertation chapter by Evelyn Brown. The draft title for the publication is:

> Effects of trends in herring egg distribution and local oceanography on Pacific Herring year-class strength. E.D. Brown, S. Vaughn, and B.L. Norcross.

For the second year of the project, the publication would most likely be entitled:

> Evidence of ecologically induced population structure and spatial segregation on Pacific herring in Prince William Sound, Alaska. E.D. Brown and these potential co-authors: B.L. Norcross, K.D.E. Stokesbury, R.J. Foy, A.J. Paul, F. Funk, J. Wilcock, T. Kline.

PROFESSIONAL CONFERENCES

During FY99 we will attend the EVOS symposium scheduled for March and the Alaska Chapter meeting of the American Fisheries Society (exact in-state location unknown). We would also like to attend the Lowell Wakefield Symposium entitled, Spatial Processes and Management of Fish Populations, October 27–30, 1999. Although this meeting occurs outside the fiscal year and would be budgeted for in FY 00, preparations and manuscripts would be prepared in FY99. In the future, we plan to participate in the International Herring Symposium scheduled for January 2000, location unknown.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project represents a synthesis of historic data and current information resulting from EVOS restoration research. Data from the SEA project (98320) and from ADFG are pivotal in the research. This will also be one of the first attempts to relate satellite data to effects on marine fishes. The results from this study also dovetail with work on herring recruitment being completed by Terry Quinn (UAF Juneau Center) and Erik Williams. The scale of the analyses differ substantially.

PRINCIPAL INVESTIGATORS

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Year	Southeast	Northeast	North Shore	Naked Area	Montague Area	Total
1973	0.00	47.47	4.83	0.00	16.09	68.39
1974	0.00	37.82	0.00	0.00	24.14	61.96
1975	0.00	44.58	0.00	0.00	10.46	55.04
1976	0.00	47.63	0.00	0.00	3.70	51.34
1977	0.00	60.75	0.00	0.00	2.41	63.16
1978	0.00	45.86	0.00	0.00	0.32	46.19
1979	33.79	52.30	0.00	0.00	1.61	87.71
1980	16.50	56.00	0.00	0.00	8.77	81.27
1981	22.29	46.67	9.25	0.00	59.14	137.35
1982	0.48	30.33	25.43	5.63	16.90	78.77
1983	4.51	21.32	16.90	28.48	37.17	108.38
1984	14.00	19.47	26.15	12.15	24.94	96.72
1985	5.15	56.32	53.83	26.31	21.24	162.86
1986	4.51	41.04	59.70	0.00	11.26	116.51
1987	11.10	34.28	42.24	3.70	13.68	105.00
1988	6.03	91.49	24.78	29.45	115.87	166.30
1989	5.63	34.76	49.40	22.05	46.51	98.40
1990	4.18	70.33	29.29	8.69	38.94	151.43
1991	6.28	45.86	1.93	0.00	39.27	93.34
1992	11.59	51.82	0.00	0.00	56.32	74.70
1993	2.74	8.85	0.00	0.00	21.24	32.83
1994	0.32	0.43	0.00	0.00	14.02	14.77
1995	9.33	3.22	0.00	0.00	20.28	32.83
1996	3.86	16.09	0.32	0.00	23.50	43.77
1997	11.30	25.10	3.40	0.00	29.00	68.70
Average	**6.94**	**39.59**	**13.90**	**5.46**	**26.27**	**83.91**
Percent Of total	**0.08**	**0.47**	**0.17**	**0.07**	**0.31**	

Table 1. Historical herring spawn shoreline kilometers from aerial and spawn deposition surveys by area and year for Prince William Sound, 1973–1997.

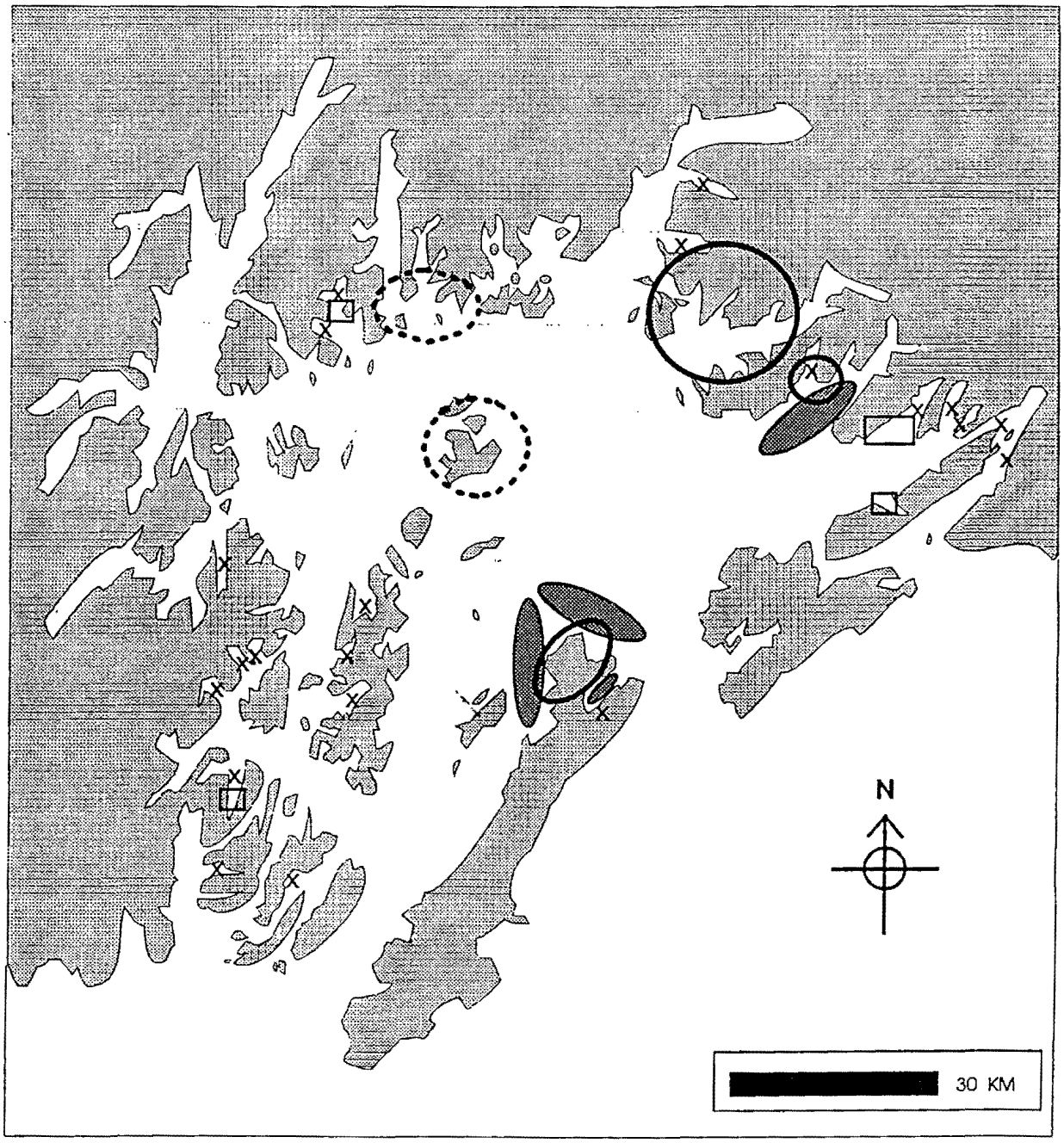

Figure 1. Map of Prince William Sound, Alaska, showing major consistent annual spawning areas (circles with solid line), major inconsistent spawning areas (circles with dotted line), minor spawning areas (squares), adult overwintering areas (shaded ovals), and juvenile nursery areas (Xs).

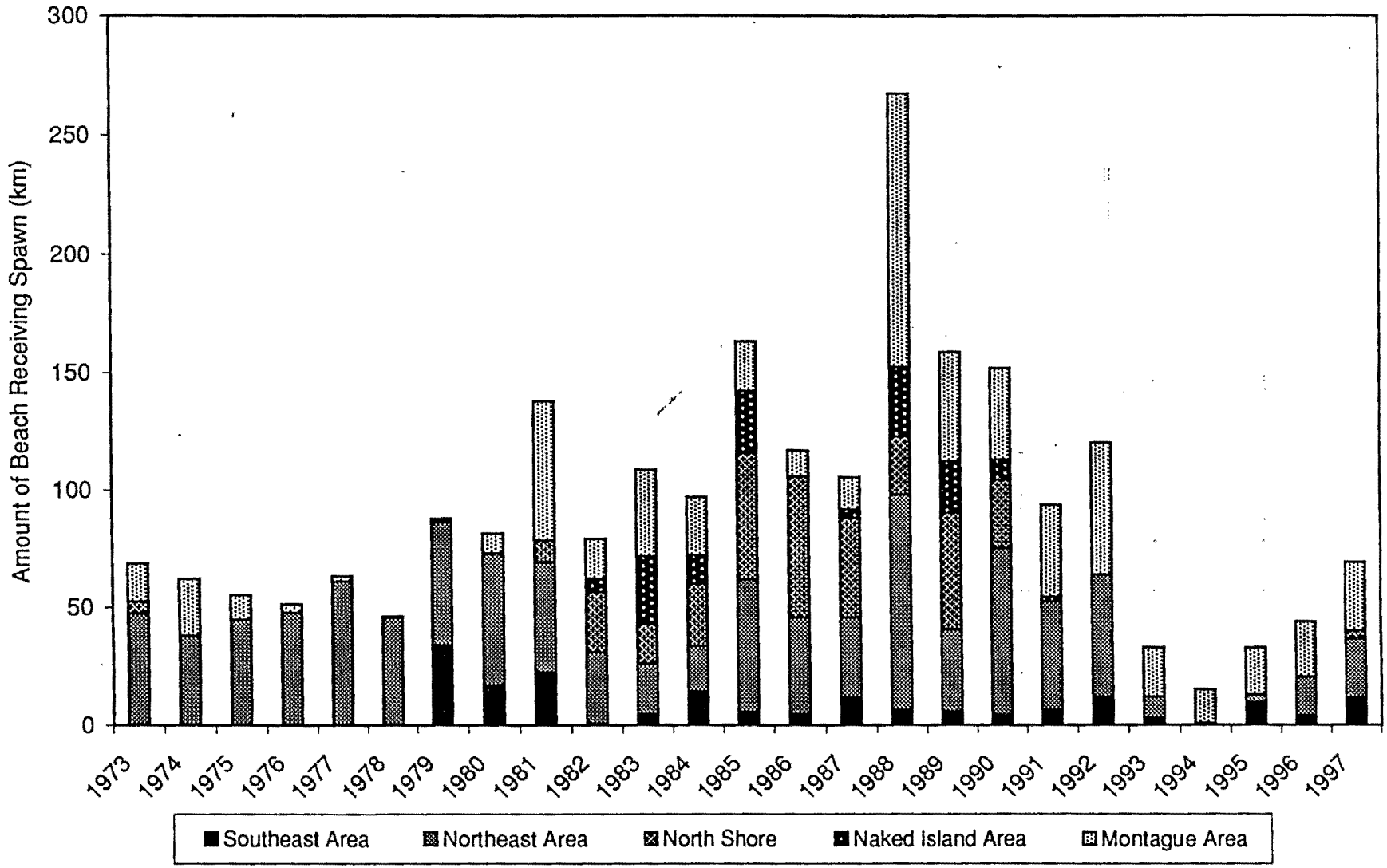

Figure 2. Interannual variability in Pacific herring spawn in Prince William Sound, Alaska.

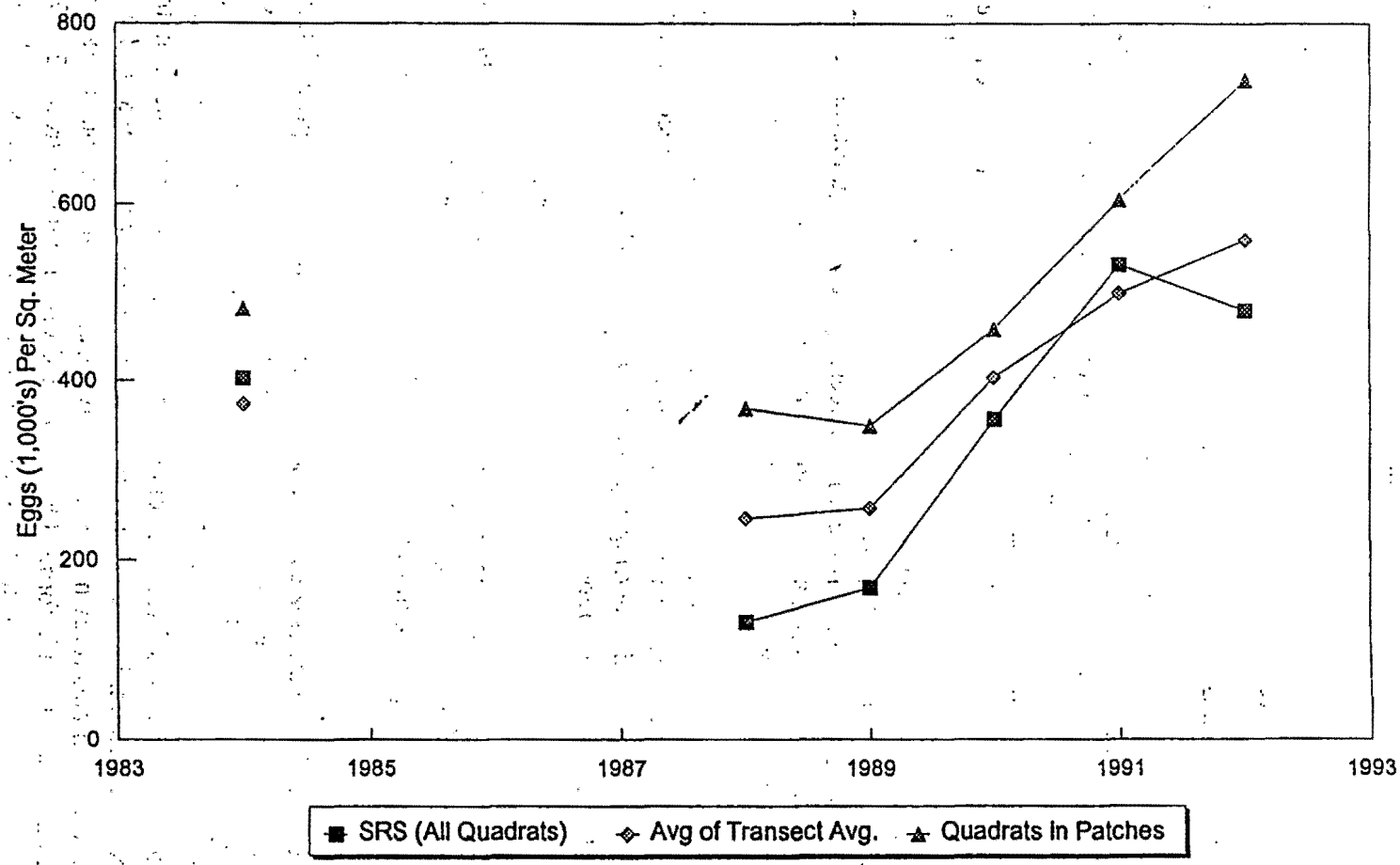

Figure 3. Interannual variation in herring eggs density estimated by the root mean squared (SRS) average from all quadra sampled, by the average egg density of all the transect averages, and by the average within a herring egg patch or area from 1984, 1988–1992 in Prince William Sound, Alaska. (Fritz Funk, ADFG, unpublished data)

Revised 7-98
Approved TC 8-13-98

FY 99 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$0.0
Travel		$0.0
Contractual		$71.5
Commodities		$0.0
Equipment		$0.0
Subtotal		$71.5
General Administration		$5.0
Project Total		$76.5
Full-time Equivalents (FTE)		0.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		

Dollar amounts are shown in thousands of dollars.

FY 99

Project Number: 99375
Project Title: Effect of Herring Egg Distribution and Ecology on Year Class Strength and Adult Distribution
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Revised 1-1-98
Approved TC 8-13-98

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$34.2
Travel		$2.0
Contractual		$20.1
Commodities		$0.9
Equipment		$0.0
Subtotal		$57.2
Indirect		$14.3
Project Total		$71.5
Full-time Equivalents (FTE)		0.5
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Dollar amounts are shown in thousands of dollars.

	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
	$48.2				

The indirect rate is 25% TDC, as negotiated by the EVOS Trustee Council with the University of Alaska.

The FY 99 estimate includes G.A. ($45.0 plus $3.2 GA).

1998

Project Number: 99375
Project Title: Effect of Herring Egg Distribution and Ecology on Year-Class Strength and Adult Distribution
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

1999 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 – September 30, 1999

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1999
Brown, E.	Principal Investigator/Project Manager		3.0	6.1		18.3
Moreland, S.	Laboratory Assistant		1.5	3.7		5.6
Engle, K.	Satellite Imagery Specialist		1.0	5.5		5.5
Vallarino, M.	Programmer		1.0	5.1		5.1
	Adjustment to recognize rounding					-0.3
		Subtotal	6.5	20.4	0.0	
					Personnel Total	$34.2

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 1999
Fairbanks to Cordova – meet with PWSSC oceanographer		0.4	1	4	0.1	0.8
Fairbanks to Anchorage – EVOS meeting		0.3	1	5	0.1	0.8
	Adjustment to recognize rounding					0.4
					Travel Total	$2.0

FY 99

Project Number: 99375
Project Title: Effect of Herring Egg Distribution and Ecology on Year-Class Strength and Adult Distribution
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 6/23/98

1999 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1998 – September 30, 1999

Contractual Costs:	Proposed
Description	FY 1999
Communications	0.3
Publication costs	0.8
Subcontract with PWSSC (oceanographer to assist with compilation of data and with satellite image interpretation)	19.1
Personnel: Vaughan 1.5 mo. = $10,650; Gay 1.0 = $5,300; Subtotal $15,950; Indirect (20%) $3,190	
Adjustment to recognize rounding	-0.1
Contractual Total	$20.1

Commodities Costs:	Proposed
Description	FY 1999
Computer supplies	0.3
Unix upgrade to S plus for GAM analysis	0.7
Adjustment to recognize rounding	-0.1
Commodities Total	$0.9

FY 99

Project Number: 99375
Project Title: Effect of Herring Egg Distribution and Ecology on Year-Class Strength and Adult Distribution
Name: University of Alaska Fairbanks

FORM 4B
Contractual & Commodities DETAIL

Prepared: 6/23/98

1999 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1998 – September 30, 1999

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

Existing Equipment Usage:	Number	
Description	of Units	

FY 99

Project Number: 99375
Project Title: Effect of Herring Egg Distribution and Ecology on Year-Class Strength and Adult Distribution
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared: 6/23/98

Revision 12-4-98
Approved TC 12-15-98

Assessment of Risk Caused by Residual Oil in Prince William Sound Using P450 Activity in Fishes

Project Number:	99379
Restoration Category:	Research
Proposer:	S. Jewett/UAF
Lead Trustee Agency:	ADFG
Cooperating Agencies:	None
Alaska SeaLife Center:	No
New or Continued:	New
Duration:	1st yr. 2 yr. project
Cost FY 99:	$115.5
Cost FY 2000:	$28.3
Cost FY 01:	$0.0
Cost FY 02:	$0.0
Geographic Area:	Prince William Sound
Injured Resource/Service:	Sea otter, river otter, harlequin duck, pigeon guillemot, nearshore fishes, subsistence

ABSTRACT

This project will determine the spatial extent of potential exposure to hydrocarbons in western Prince William Sound by examining P450 activity in two coastal fishes, masked greenling and crescent gunnel. These fishes live and feed in the nearshore zone, and provide an index of exposure for fishes and other vertebrates. In addition, the project will examine the relationship between P450 levels in these fishes, hydrocarbon concentrations in sediments, and hydrocarbon metabolites in these fishes to help determine if exposure is from residual oil from the *Exxon Valdez* spill.

INTRODUCTION

Approximately 14 months after the *Exxon Valdez* Oil Spill (EVOS), elevated P4501A levels were noted in several intertidal fish in Prince William Sound (PWS) (Woodin and Stegeman, 1993). Elevated P4501A, as well as biliary fluorescent aromatic compounds (FACs) were also observed in several subtidal fishes up to two years after EVOS (Collier et al., 1996). By 1996, significant contamination, as seen in P450 RGS, was still observed in Pacific sand lance (*Ammodytes hexapterus*), but the fish tissue did not contain detectable amounts of polycylic aromatic hydrocarbons (PAHs) (Anderson and Jones, 1997).

Traces of residual oil from the EVOS can still be found in sediments in some coastal areas of PWS (e.g., Munson and Brodersen, 1998; Jewett and Dean, 1997). One habitat that still shows relatively high oil concentrations is blue mussel (*Mytilus trossulus*) beds and underlying sediments (Babcock et al., 1996). Treated mussel beds that had shown decreased hydrocarbon concentrations in mussels and sediments through 1995 now indicate recontamination. As a result, monitoring of oiled mussel beds in PWS will resume in 1999 (Restoration Project 99090: Harris and Brodersen, 1998). Elevated levels of cytochrome P450A1 (P450) have been observed recently in a number of higher-order vertebrates that live or feed in the nearshore environment (Holland-Bartels et al., 1998). Sea otters, river otters, Barrow's goldeneye, and masked greenling all show evidence of continued exposure to hydrocarbons. It is uncertain whether elevated P450 levels are the result of exposure to residual oil or other hydrocarbons, but the fact that animals with elevated levels are largely restricted to parts of the Sound that were heavily oiled suggests a connection with residual oil from the *Exxon Valdez*. The potential consequences of exposure to populations or to individual animals are also unknown, but there is a strong correlation between exposure to oil and a lack of recovery in vertebrate populations (Holland-Bartels et al., 1998).

In spite of its importance to recovery, we know little about the spatial distributions of potential exposure of hydrocarbons. We cannot determine spatial patterns of exposure by direct measurement of hydrocarbons in sediments because of small-scale spatial variability in hydrocarbon concentrations (and also because of the high cost of hydrocarbon analyses). High variability in sediment total polynuclear aromatic hydrocarbon (TPAH) concentrations was evident in heavily oiled sites shortly after the EVOS (Houghton et al., 1993; O'Clair et al., 1996). However, more recently, sediments had a low incidence of elevated hydrocarbons in spite of indications of continued hydrocarbon exposure (Jewett and Dean, 1997). It is difficult to indirectly infer spatial distributions of exposure by measurement of P450 in most vertebrates (e.g., sea otters or birds) because they are difficult to sample. Also, many of these animals integrate exposure from over large areas, which also reduces our ability to perceive spatial patterns of exposure.

We propose to sample coastal fish species in PWS to serve as an index of oil exposure for these and other vertebrate populations. Three tasks are proposed: 1) examine the spatial distribution of potential exposure to hydrocarbons, 2) examine the relationship between P450s in fishes and sediment hydrocarbons, and 3) examine the relationship between fish hepatic P450 activity and biliary fluorescent aromatic compounds (FACs).

Task 1 will examine the spatial extent of exposure by measuring P450 levels in the livers of masked greenling (*Hexagrammos octogrammus*) and crescent gunnel (*Pholis laeta*) collected and archived in 1998 from a variety of oiled and unoiled locations. Masked greenling are a benthic fish, common in the Sound, which live in relatively close proximity to the bottom and feed on a variety of benthic invertebrates (Tables 1 and 2). Crescent gunnel are found in the rocky intertidal zone, as well as in the shallow subtidal, and also feed on benthic organisms. River otters prey on both fish species and pigeon guillemots take crescent gunnel (Holland-Bartels et al., 1998). We have no direct measurements of home ranges for masked greenling, but we know they are territorial while defending egg masses in fall, and suspect that they have a relatively limited home range at other times of the year (perhaps on the order of hundreds of meters). Crescent gunnel have been observed in the Sound during June through August. Failed attempts to find them during September suggest they may go deeper after summer months. We measured P450 activity in the livers of masked greenling collected in 1996 from Herring Bay (an oiled site) and Jackpot Bay (a reference site). There was significantly higher P450 activity in the fish from Herring Bay compared with those from Jackpot Bay (Holland-Bartels et al., 1998; Figure 1). Furthermore, spatial patterns of P450 in fish from Herring Bay suggest that fish from more heavily oiled parts of the bay may have higher P450 levels. Fish collected from within 100 m of moderately to heavily oiled sites (as determined by shoreline surveys conducted in 1989 and 1990) had average P450 levels of 5.4 (N = 4, range = 3 to 7.5). In contrast, fish collected from shorelines with no oil within 100 m had average P450 levels of 2.8 (N = 3, range = 1.5 to 4). While clearly preliminary, these data on biochemical effects reveal that fish in PWS are being exposed to xenobiotics (e.g., PAHs, PCBs, and dioxins); that the likely source of exposure is residual oil from the *Exxon Valdez* spill; and that masked greenling are relatively sensitive indicators of local hydrocarbon exposure, useful for determining spatial patterns of exposure to fish as well as other vertebrates. Crescent gunnel from the intertidal region offer insight into hydrocarbon exposure where greatest concentrations of oil were deposited.

Task 2 will examine the relationship between concentrations of hydrocarbons in sediments and activity of P450 in fishes to help determine the likelihood that elevated P450 levels are caused by exposure to residual *Exxon Valdez* oil. This will be accomplished mainly by comparing P450 in fishes adjacent to oiled mussel beds and hydrocarbons in sediments beneath the beds.

Task 3 will determine if PAHs are still being metabolized (as noted by FACs in fish bile) and if exposure to PAHs is the probable cause for elevated P450 activity. This task will be accomplished by comparing P450s and FACs in fishes adjacent to oiled mussel beds.

NEED FOR THE PROJECT

A. Statement of Problem

Mounting evidence shows that nearshore vertebrates in Prince William Sound, some of which have not fully recovered following the EVOS, are being exposed to hydrocarbons. However, the spatial patterns of potential exposure and the pathways of exposure remain unknown. Furthermore, there is currently no cost-effective means of measuring the risk of potential exposure.

B. Rationale/Link to Restoration

The degree and tissue localization of P450 expression in fish should help to determine spatial patterns of exposure. These data could then be used to identify specific areas within the Sound that may need additional monitoring or cleanup. Furthermore, if "hot spots" of potential exposure to oil can be identified, then there may be ways of keeping nearshore vertebrates (and subsistence users) from these sites, thereby reducing exposure.

Also, development of sensitive but inexpensive indices of exposure is important to future monitoring. Sampling TPAHs or other hydrocarbons in sediments is impractical because extremely large sample sizes are required to overcome the low probability of detecting significant contamination because of spatial variability. The measurement of P450 in fish may, on the other hand, serve as an important tool that provides a more spatially integrated exposure index that is both sensitive and relatively inexpensive.

C. Location

Most sampling will be conducted in western Prince William Sound, mainly in the vicinity of Knight, Naked, and northern Montague islands. The project's benefit of providing knowledge about continued exposure to oil would be realized mainly in the Sound, but monitoring efforts could be expanded to other areas.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

No community involvement or use of traditional ecological knowledge is anticipated for this investigation. Knowledge about the relative distribution, abundance, and size of the target fishes has been attained through previous surveys in the Sound and elsewhere.

PROJECT DESIGN

A. Objectives

The objectives of the proposed study are to 1) identify the spatial extent of potential hydrocarbon exposure in nearshore fishes and 2) establish associations between sediment hydrocarbon concentrations in intertidal mussel beds and P450s in fishes adjacent to mussel beds.

B. Methods

Task 1–Identify the spatial extent of potential hydrocarbon exposure.

Sampling–Masked greenling and crescent gunnel (both < 20 cm TL) were collected on an opportunistic basis from oiled and reference bays in western PWS to serve as surrogate indicators of oil exposure. Sampling for masked greenling was conducted along shallow (< 5 m) shoreline

segments using hook and line. Sampling took place in the summer of 1998, simultaneous with research for another EVOS project (NVP: Project 98025). Based on the masked greenling sampling in Herring Bay in 1996, we estimated that a sampling of eight fish per site would be sufficient to detect a 50% difference in P450 activity between sites with an 80% power (α = 0.05). Therefore, eight specimens of masked greenling were collected from each of five oiled bays (Northwest Bay, Snug Harbor, Bay of Isles, Sleepy Bay, and Herring Bay) and five reference bays (Cabin Bay, Rocky Bay, Port Chalmers, Mummy Bay, and Stockdale Harbor) (Figure 2). In addition, eight specimens of crescent gunnel were collected under rocks intertidally from each of two oiled bays (Herring Bay and Bay of Isles) and two reference bays (Mummy Bay and Port Chalmers). All fish were euthanized by a blow to the head before being preserved in 5% formalin solution. The peritoneal cavity was opened to ensure complete preservation of internal organs. These fish will be shipped to Dr. John Stegeman at Woods Hole Oceanographic Institution (WHOI) for cytochrome P450 1A analyses in early 1999.

P450 analyses–Mixed function oxygenases (MFOs) are enzymes that play a critical role in detoxification of numerous endogenous compounds (such as steroids) and exogenous organic compounds (such as ethanol, drugs, and aromatic hydrocarbons). Cytochrome P450s are a family of iron-containing hemoproteins that catalyze the MFO reactions. The induction of cytochrome P450 by chemical exposure, and the specificity of induction of different members of the cytochrome P450 family by various compounds, have been demonstrated in experimental studies (Stegeman et al., 1992). A specific cytochrome P450, 1A (CYP1A), is induced in vertebrates by aromatic hydrocarbons, including polycyclic aromatic hydrocarbons found in oil, and halogenated aromatic hydrocarbons, including PCBs. CYP1A thus can serve as a sensitive biomarker of exposure to these environmental contaminants. When organic compounds are "detoxified," the resulting metabolites may be inactive or, in some cases, they actually may be more toxic than the original compounds. Thus, elevated levels of cytochrome P450 not only indicate exposure but, potentially, deleterious effects to the animal. Tissues will be sectioned and processed, and CYP1A will be measured by an immunohistochemical assay (Goksøyr et al., 1991; Stegeman, 1989) using an antibody specific to the CYP1A protein in masked greenling and crescent gunnel livers. The occurrence and intensity of intracellular staining will be scored by light microscopy. Higher scores correspond to increased levels of CYP1A in samples (Woodin et al., 1997). A total of 80 masked greenling samples (10 sites x 8 fish x 1 tissue [liver]) and 32 samples of crescent gunnel (4 sites x 8 fish x 1 tissue [liver]) will be analyzed.

Statistical analysis–Indices of CYP1A activity will be compared between sites using one-way analysis of variance. Two ANOVAs will be performed, the first comparing oiled and unoiled sites (with site means as the sampling unit) and the second comparing all sites (with individual fish as the sampling unit). In the latter, *a posteriori* contrasts will be conducted to identify sites with higher potential for exposure, as indicated by higher CYP1A activity levels. We will also examine the spatial relationship between historical levels of shoreline oiling and CYP1A by overlaying CYP1A levels on a map of oiling levels (unoiled, lightly oiled, moderately oiled, etc.) and by contrasting CYP1A activity in different oiling categories using a one-way ANOVA.

The proposed cost for Task 1 is $39,900.

Task 2–Identify relationships between hydrocarbons in mussel bed sediments and P450s in fishes adjacent to mussel beds.

Sampling–Masked greenling and crescent gunnel (both < 20 cm TL) will be collected in mid June adjacent to oiled and reference mussel beds in PWS and will serve as surrogate indicators of oil exposure. Sampling will occur at a subset of locations where hydrocarbons in mussels and sediments will be monitored by NMFS, Auke Bay Laboratory (ABL) in 1999 (Restoration Project 99090). Sampling will occur adjacent to eight oiled, untreated mussel beds and two reference mussel beds.

Unrestored mussel beds proposed for sampling in 1999 are:

Beach Segment	Geographic Name	Oiled or Reference
CH009A-3	Chenega Island	oiled
DI067A-6	Disk Island	oiled
EL013A	Eleanor Island	oiled
KN004-2	Bay of Isles	oiled
KN133A-1	Herring Bay	oiled
KN505A	Herring Point	oiled
LA015E-2	Latouche Island	oiled
MA002C	Foul Bay	oiled
KN575A	Barnes Cove	reference
OLSEN	Olsen Bay	reference

Eight masked greenling will be collected in shallow (< 5 m) water adjacent to each beach segment using hook and line. Eight crescent gunnel will be collected by hand from under rocks intertidally at each beach segment. All fish will be euthanized by a blow to the head. Livers will be removed, preserved in 5% formalin solution, and shipped to Dr. John Stegeman in the fall of 1999 for cytochrome P4501A analyses. Sediment hydrocarbons will be collected by ABL personnel on a shared platform with the fish samplers. Briefly, a transect, generally 30 m long and parallel to the water line, will be established through the middle of the mussel bed. Three pooled subsamples of surficial sediment (0–2 cm deep) under the mussels will be collected with a HC-free stainless steel spoon into each of three HC-free glass jars (Restoration Project 99090).

P450 analyses–Induction of CYP1A will be determined (as described for Task 1) in 160 samples (10 sites x 2 species x 8 fish x 1 tissue [liver]).

Chemistry analysis–Sediment samples will be analyzed at the ABL (Restoration Project 99090). Samples will be analyzed by ultraviolet fluorescence as adapted from Krahn et al. (1991) and used successfully at ABL since 1992. Concentrations will be reported in µg total hydrocarbons /g wet weight of sediment (TPH). Sediments will also be analyzed by gas chromatography/mass spectroscopy (GC/MS) if TPH concentrations are above pre-spill levels in a bed. Hydrocarbon data will be provided for comparison with P450 data.

Statistical analysis–The relationship between P450 levels and hydrocarbon concentrations will be examined by correlating mean P450 values and mean sediment hydrocarbon concentrations from each site.

The proposed cost for Task 1 is $68,600.

Task 3–Identify the relationship between P450 activity and FACs in fishes.

Sampling–Bile will be collected from all fish sampled in Task 2, according to the protocol established by Stehr et al. (1993).

Chemical analysis–Measurement of FAC in bile will be conducted at the NOAA/NMFS, Seattle, WA (contact: Dr. Margaret Krahn) according to the protocol of Varanasi et al. (1995). Analyses for biliary FACs will be carried out at fluorescence wavelengths appropriate for phenanthrene and naphthalene. These two wavelengths have been shown to be most useful for determining petroleum exposure in fish (Krahn et al., 1992). Only specimens that have elevated P450s will be examined for FACs; up to 60 samples are budgeted. It is anticipated that the P450 results will not be available until August 1999; therefore, FAC analysis will not commence until October 1999 (FY00).

Statistical analysis–The relationship between P450s and FACs will be examined by correlating mean P450 values and mean FAC values for each site.

The proposed cost for Task 3 is $12,800.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

This proposal is for a collaborative research project with participation by scientists from university, federal, and private research centers. It is being submitted by the University of Alaska Fairbanks (UAF), with collaborators from NMFS ABL, Woods Hole Oceanographic Institution (WHOI), and Coastal Resources Associates, Inc. (CRA), through the Alaska Department of Fish and Game as the trustee agency. Professional services contracts will be used to transfer funds from UAF to WHOI and CRA. Collaboration with NMFS Seattle (FY 00) will also occur through NOAA as the trustee agency.

SCHEDULE

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

January–March:	Analyze 1998 P450 samples, arrange logistics for June cruise
June:	Collect samples
July–August:	Analyze P450 and sediment hydrocarbon samples
September:	Prepare draft annual report

B. Measurable Project Tasks for FY 00 (October 1, 1999 – September 30, 2000)

October:	Analyze biliary FAC at NMFS, Seattle
April:	Prepare draft final report

C. Project Milestones and Endpoints

March 1999:	Completion of P450 analysis on 1998 samples
June:	Completion of sediment and fish collections
August:	Completion of P450 and sediment hydrocarbon data analyses
September:	Submit draft annual report
December:	Completion of FAC and P450 analyses
April 2000:	Submit draft final report
September:	Submit final report

C. Completion Date

September 30, 2000 (FY 00)

PUBLICATIONS AND REPORTS

We cannot yet anticipate publication schedules for FY 00. Manuscript(s) for publication would presumably be produced after the final report. The final report will be produced as indicated in the above schedule. Possible journals for publishing our findings are: *Fish Physiology and Biochemistry*, *Marine Environmental Research*, and *Environmental Science and Technology*.

PROFESSIONAL CONFERENCES

A presentation of the finding of this research will target the Society of Environmental Toxicology and Chemistry (SETAC) to be held in Philadelphia, PA, November 1999. It is undetermined at this time whether the Principal Investigator or other key personnel will present the finding.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This proposal has been developed as a collaborative effort among research scientists from UAF, NMFS ABL, NMFS Seattle, WHOI, and Coastal Resources Associates, Inc. Stephen Jewett of UAF will coordinate the research. The Alaska Department of Fish and Game will serve as the lead trustee agency. The project represents a unique cost-saving opportunity because no funds are needed to obtain the 1998 fish samples. Those samples were collected on an opportunistic basis while sampling during the final year (summer of 1998) of the Nearshore Vertebrate Predator project (98025). Sampling in 1999 will be integrated with ABL (99090) so that fish sampling by UAF and mussel/sediment sampling by ABL will carried out at the same locations from the same

platform. Collaboration with NMFS Seattle will be facilitated through NOAA as the lead trustee agency; therefore, no cost for their involvement is included in this budget.

PROPOSED PRINCIPAL INVESTIGATOR

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Table 1. Volumetric stomach contents of fishes collected in Alaska. "+" indicates < 1% stomach contents volume.

Fish Species	Number analyzed	Standard length (mm)	PREY TAXON Copepods	Gammarid Amphipods	Caprillid Amphipods	Shrimps	Other Crustaceans	Polychaetes + Echiurids	Bivalves	Snails	Fishes
Hexagrammos octogrammus #	188	45-195	3	27	44	+	2	20	1	1	+
Pholis laeta #	12	70-159	12	33	41	0	5	+	1	1	3

#: Source: McConnaughey (1978)

Table 2. Habitat preferences, behavior and predators of tow nearshore fishes of Prince William Sound.

Species	Habitat	Behavior	Predators
Hexagrammos octogrammus (masked greenling)	Shallow rocky areas with kelp canopy	Solitary bottom dweller & benthic feeder; moves to shallow depths in summer to spawn on rocky substrate, returns to depth in fall.	River otter, other fishes
Pholis laeta (crescent gunnel)	Intertidal to 80 m over variable substrate with kelp or eelgrass	Solitary bottom dweller & benthic feeder; moves to shallow depths in summer, returns to depth in fall.	River otter, pigeon guillemot, other fishes

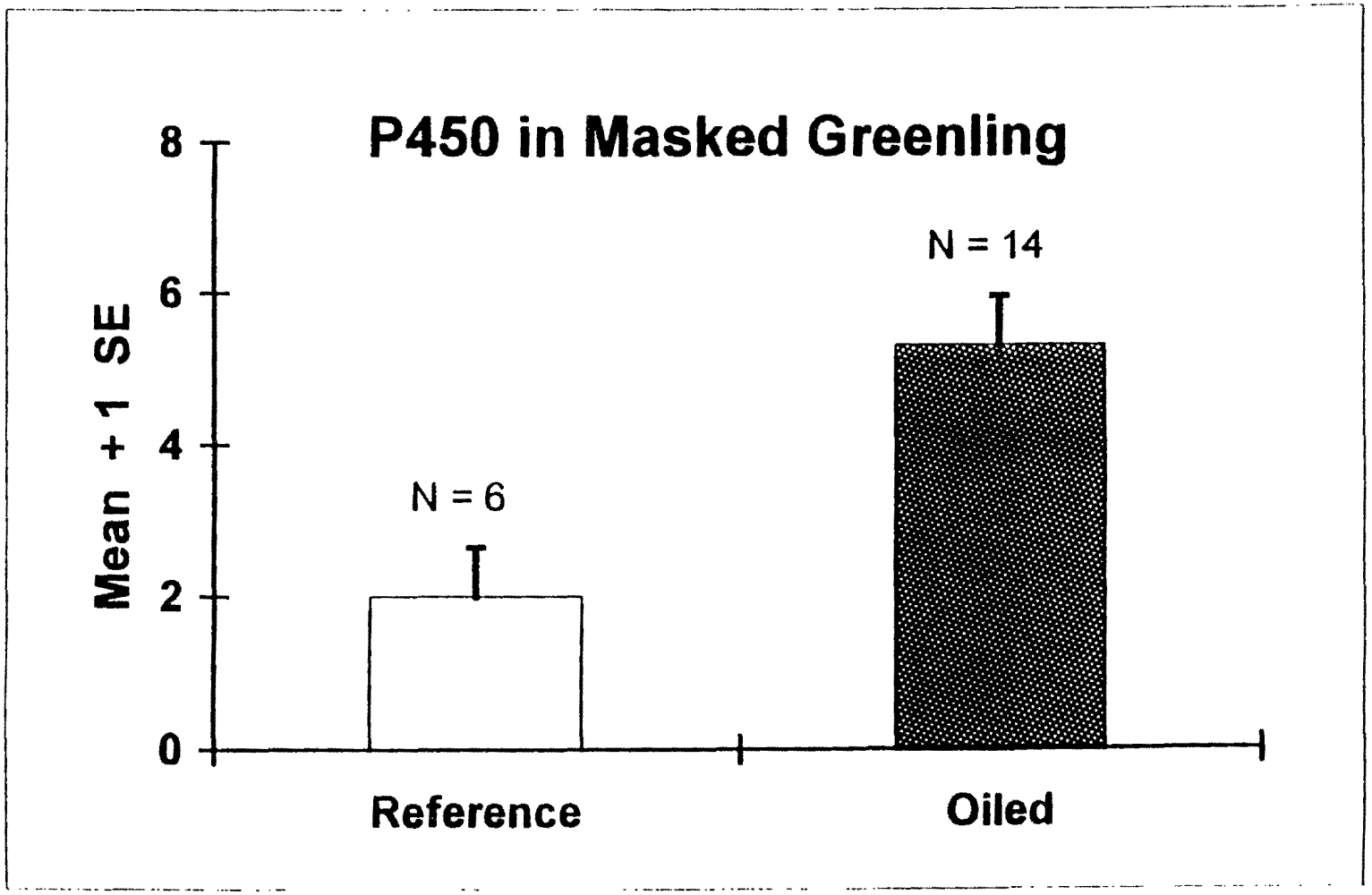

Figure 1. Comparison of cytochrome P450 (CYP1A) in masked greenling from oiled Herring Bay and unoiled (reference) Jackpot Bay, Prince William Sound, 1996.

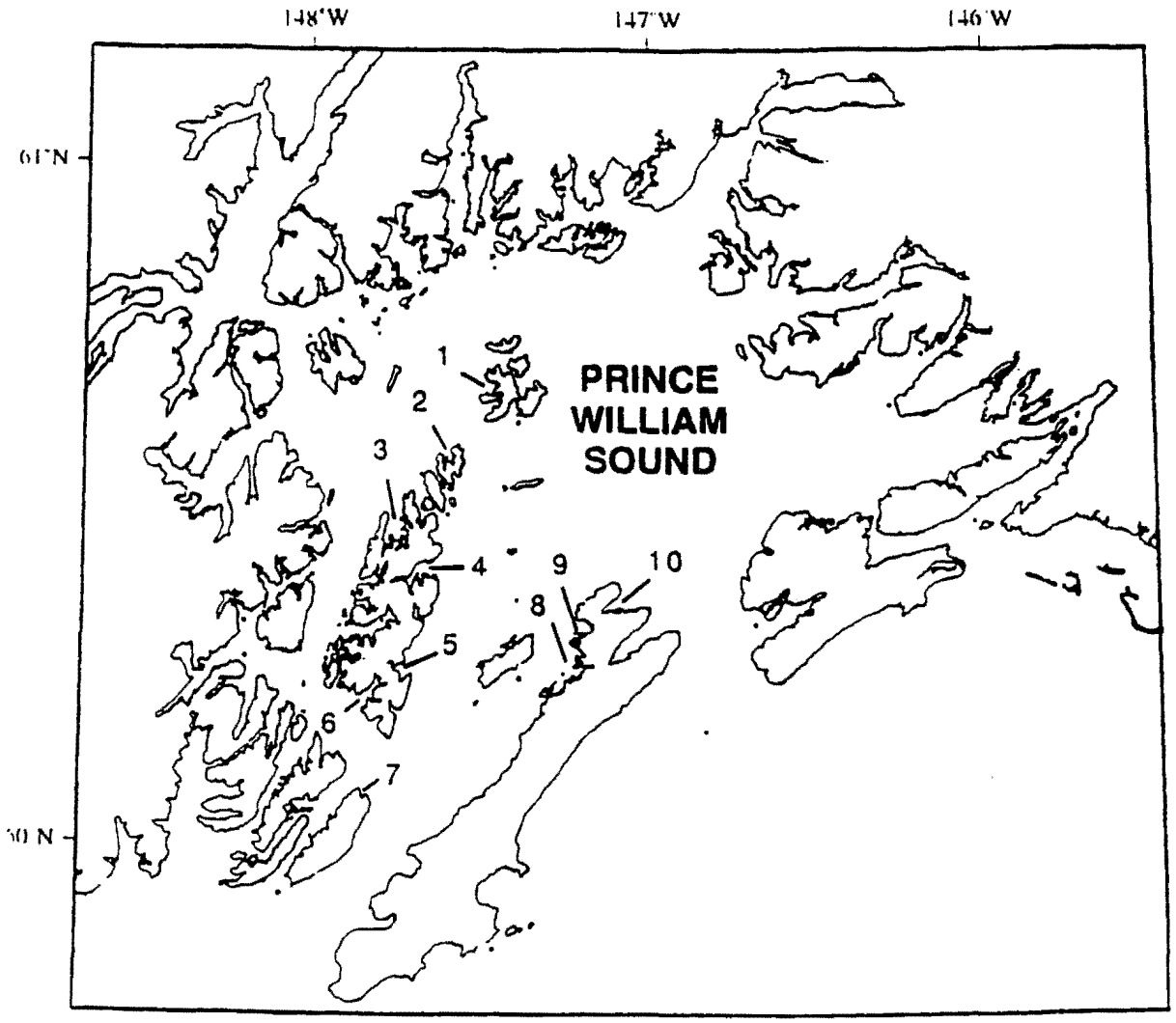

Figure 2. Fish sampling locations for P450 in 1998.
1 = Cabin Bay, 2 = Northwest Bay, 3 = Herring Bay, 4 = Bay of Isles,
5 = Snug Harbor, 6 = Mummy Bay, 7 = Sleepy Bay, 8 = Port Chalmers,
9 = Stockdale Harbor, 10 = Rocky Bay.

Revision 12-18
approved TC 12-15-98

FY 99 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$0.0
Travel		$0.0
Contractual		$107.9
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$107.9
General Administration		$7.6
Project Total	$0.0	$115.5
Full-time Equivalents (FTE)		0.0

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
		$28.3	$0.0		

Dollar amounts are shown in thousands of dollars.

Other Resources

Comments:

FY 99

Project Number: 99379
Project Title: Assessment of Risk Caused by Residual *Exxon Valdez* Oil in PWS Using P450 Activity in Fishes
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2/11/99

Revision -4-98
(corrected)
Approved TC 12-15-98

1999 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 – September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$20.8
Travel		$2.6
Contractual		$64.4
Commodities		$0.2
Equipment		
Subtotal		$88.0
Indirect		$19.9
Project Total		$107.9
Full-time Equivalents (FTE)		0.3
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
$28.3				

Dollar amounts are shown in thousands of dollars.

Comments:

The indirect rate is 25% TDC (5% for subcontract amounts over $25,000), as negotiated by the *Exxon Valdez* Oil Spill Trustee Council with the University of Alaska.

FY2000 budget includes analysis of up to 60 bile samples that may be done by NOAA. The budget includes personnel of $11,100, GA of $1,700, with a total of $12,800.

FY 99

Project Number: 99379
Project Title: Assessment of Risk Caused by Residual *Exxon Valdez* Oil in PWS, Based on P450 Activity in Fishes
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

Prepared: 12/4/98

1999 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 – September 30, 1999

Personnel Costs: Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 1999
Jewett, S.	Principal Investigator/Research Prof.		2.0	8.0		16.0
Hoberg, M.	Technician		1.0	5.0		5.0
	Adjustment to recognize rounding					-0.2
	Subtotal		3.0	13.0	0.0	
					Personnel Total	$20.8

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1999
Fairbanks to PWS - field cruise	0.4	2	4	0.1	1.3
Boston to Anchorage – EVOS meeting (Dr. Stegeman)	0.7	1	5	0.1	1.3
				Travel Total	$2.6

FY 99

Project Number: 99379
Project Title: Assessment of Risk Caused by Residual Exxon Valdez Oil in PWS, Based on P450 Activity in Fishes
Name: University of Alaska Fairbanks

FORM 4B
Personnel & Travel
DETAIL

Prepared: 12/7/98

1999 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1998 – September 30, 1999

Contractual Costs:	Proposed
Description	FY 1999
Subcontract to Coastal Resources Associates, Inc. – participation of researcher T. Dean in project	21.5
Subcontract to Woods Hole Oceanographic Institution – participation of researcher J. Stegeman and processing of 272 P450 samples @ $130 each	35.3
Boat charter (10 days @ $750/day)	7.5
Communications	0.1
Contractual Total	$64.4

Commodities Costs:	Proposed
Description	FY 1999
Amber vials for storing bile	0.2
Commodities Total	$0.2

FY 99

Project Number: 99379
Project Title: Assessment of Risk Caused by Residual Exxon Valdez Oil in PWS, Based on P450 Activity in Fishes
Name: University of Alaska Fairbanks

FORM 4B
Contractual & Commodities
DETAIL

Prepared: 12/4/98

1999 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 – September 30, 1999

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

Existing Equipment Usage:		
Description	Number of Units	

FY 99

Project Number: 99379
Project Title: Assessment of Risk Caused by Residual Exxon Valdez Oil in PWS, Based on P450 Activity in Fishes
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared: 12/4/98

4/15 file
approved TC 12-15-98

STATUS OF SEABIRD COLONIES IN NORTHEASTERN PRINCE WILLIAM SOUND

Project Number:	99381
Restoration Category:	Monitoring
Proposer:	Pacific Northwest Research Station, U.S. Forest Service
Lead Trustee Agency:	U.S. Forest Service
Cooperating Agencies:	U.S. Fish and Wildlife Service
Duration:	1 year
Cost FY 99:	$13.0
Cost FY 00:	$ 1.0
Geographic Area:	Prince William Sound
Injured Resource:	Black oystercatcher, pigeon guillemot

ABSTRACT

In northeastern Prince William Sound, existing documentation on seabird colonies is either inadequate or outdated. With the most recent colony data from 6-24 years old, current documentation may not reflect recent changes in size, species composition, and location that may have occurred since the *Exxon Valdez* oil spill. Areas around northeastern Prince William Sound (Port Gravina to Orca Inlet) are pending purchase by the Trustee Council to aid in the restoration of injured species. These lands, however, may be subject to increased human pressure in three ways: 1) increased wildlife and fishing tours generated by newly scheduled cruise ship stopovers in Cordova, 2) greater access to Prince William Sound due to the construction of the road from Portage to Whittier, and 3) the conversion of acquired parcels from private land to public land. All of these factors may increase human/wildlife interactions. We intend to establish current population data for the seven known colonies in these areas and survey the coastline for suspected and unknown seabird colonies. Acquisition of this information is necessary to minimize human disturbance of injured species.

INTRODUCTION

The purchase of fee simple lands and conservation easements by the *Exxon Valdez* Oil Spill (EVOS) Trustee Council will conserve lands and aid in the recovery of injured species. In particular, the pending purchase of land in the northeastern part of the Prince William Sound (PWS) around Sheep Bay and Port Gravina are considered among the most valuable lands in the Sound for the recovery of injured species (EVOS 1997). However, the conversion from private lands to public lands will also increase recreational opportunities and public access. The road under construction from Portage to Whittier, as well as guided fishing and wildlife tours for cruise ship passengers visiting Cordova, will create additional use of these lands and their adjacent waters. This elevated activity may lead to increased human/wildlife interactions. It is important to understand where wildlife is at risk of disturbance to make sound management decisions.

In northeastern Prince William Sound, there have been no systematic surveys for seabird colonies, and existing documentation is inadequate or outdated. For many seabird species, colonies may change size and location from year to year in response to food availability, food quality, and disturbance. For example, Irons et al. (1998) found substantial changes in black-legged kittiwake (*Rissa tridactyla*) colonies over time in Prince William Sound, probably due to changes in forage fish composition and abundance. Arctic terns (*Sterna paradisaea*) have been known to abandon colonies in response to disturbance and/or habitat degradation (Hawksley 1957). Terns are particularly susceptible to human disturbance because they often nest in flat, grassy areas that are attractive to campers and picnickers.

Currently there are seven known seabird colonies from Port Gravina to Simpson Bay (U.S. Fish and Wildlife Service 1998a), and an eighth suspected pigeon guillemot colony in Nelson Bay (northern Orca Inlet; Sanger and Cody 1994). At least four of these colonies support two injured species (black oystercatchers, *Haimatopus bachmani,* and pigeon guillemots, *Cepphus columba*), but only two of these colonies have been surveyed since the *Exxon Valdez* oil spill. The other five were surveyed either 14 or 26 years ago (U.S. Fish and Wildlife Service 1998a). Of these colonies, four have high potential for human disturbance: two that are situated near commonly used anchorages (Lethcoe and Lethcoe 1985), one that is near a popular sport fishing area, and one that is near a commercially owned weatherport. Because seabird colonies can be negatively affected by human disturbance (Gillet et. al 1975, Ellison and Cleary 1978, Anderson and Keith 1980), current knowledge of colony locations is important to lessen the impact of increased demand on public land in this area.

NEED FOR THE PROJECT

A. Statement of Problem

Existing documentation for seabird colonies is limited or outdated. With most recent surveys conducted 6-24 years ago, colonies may have changed in size, species composition, and location. At the same time, increases in human activity in PWS are expected in the future. The Alaska

Department of Transportation (ADOT) has estimated that human activity in PWS will increase 600% by 2015 (ADOT 1995). Seabird colonies are often susceptible to human disturbance (Gillet et. al 1975, Ellison and Cleary 1978, Anderson and Keith 1980). For this reason it is important to document where colonies exist to safely handle the expected increase in human activities.

B. Rationale/Link to Restoration

Lands in northeastern PWS are being purchased for the recovery of injured species. This recovery could be offset by increased human activity on these lands, especially recreational fishing and wildlife viewing. At least two injured species (black oystercatcher and pigeon guillemot) nest in these areas. Knowledge of seabird colony locations will allow management agencies to reduce human pressure on sensitive areas.

C. Location

The study area consists of the shoreline, islands and offshore rocks in northeastern PWS. This includes Port Gravina, Sheep Bay, Simpson Bay, the Narrows (Channel Islands), and Nelson Bay (northern Orca Inlet). This area coincides with lands being purchased from the Eyak Corporation by the *Exxon Valdez* Oil Spill Trustee Council.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Through the Chugach School District Youth Area Watch program, we will attempt to involve one or two high school students from Cordova or eastern Prince William Sound in the collection of data.

PROJECT DESIGN

A. Objectives

FY99.

1. Determine the status, species composition, and population of known seabird colonies in northeastern PWS.

2. Systematically survey northeastern PWS shoreline, islands, and offshore rocks for undocumented seabird colonies.

3. Incorporate local community members in the collection of data through the Youth Area Watch program.

B. Methods

Surveys will be conducted 1-20 June. This coincides with breeding activity for most species of seabirds and is the recommended time to survey for pigeon guillemots (Sanger and Cody 1994). We will use a 5.2-m skiff traveling at approximately 5 knots to survey shoreline, islands, and offshore rocks for seabirds and black oystercatchers. Upon encountering a colony, location will be recorded on 1:64,000 aerial photographs, and GPS coordinates will be taken. We will determine the number of birds present using protocols developed by U.S. Fish and Wildlife Service for the Alaska Seabird Colony Database. Depending on species, counts will be conducted from the boat offshore, from land by walking within the colony, or from land by using a viewpoint outside the colony (U.S. Fish and Wildlife Service 1998b). Counts of pigeon guillemot colonies will be conducted on the morning high tide (K. Kuletz, U.S. Fish and Wildlife Service, pers. comm.).

We will attempt to count entire colonies, recording for each species the number of individual birds (or pairs) and the number of nests (for black-legged kittiwakes and cormorants). If the entire colony cannot be counted, we will count a portion and estimate the entire size, or where appropriate, use plots or transects. We will also record the stage of breeding and signs of predators and other marine species. Habitat information will include area (length and width), substrate, vegetation type, height of cliff, and aspect, and means to access (U.S. Fish and Wildlife Service 1998b).

C. Cooperating Agencies, Contracts, and Other Agency Assistance

During FY99 the Pacific Northwest Research Station will contribute resources in the form of personnel costs for the Principal Investigator (1/2 month in-kind) and Assistant Project Leader (1 week in-kind) as well as field equipment (17-ft Boston Whaler with motor, camping supplies). Other agency contributions to this project include equipment loans from the Copper River Delta Institute and Cordova Ranger District, Chugach National Forest. Cooperation for community involvement will be sought through the EVOS Restoration Office and the Youth Area Watch Program.

SCHEDULE

A. Measurable Project Tasks for FY99

May 1-15:	Coordination with Youth Area Watch Program
June1-20:	Conduct Surveys and Colony Counts
July 1-15:	Prepare Report, Distribute Data

B. Project Milestones and Endpoints

June 20:	Complete Survey and Colony Counts
September 30:	Submission of Final Report, Distribution of Data

C. Completion Date

The final report for this project will be submitted to the Restoration Office before April 15 2000.

PUBLICATIONS AND REPORTS

The final report for this project will be submitted to the Restoration Office before 15 April 2000. Information from this project will be published in the Alaska Seabird Colony Catalog and Database, published and maintained by the U.S. Fish and Wildlife Service, Anchorage, AK.

PROFESSIONAL CONFERENCES

No conferences are anticipated in FY99. We will present a poster at the annual EVOS conference in 2000.

NORMAL AGENCY MANAGEMENT

The work proposed here is not part of normal agency management and is related specifically to research addressing oil spill restoration concerns. The need for this work is generated by the purchase of lands by the Trustee Council and the presence of injured species on these and nearby lands. No similar work has been conducted, is currently being conducted, or is planned using agency funds. Ultimately, management of these lands will require coordination between native corporations and federal agencies. This project will provide useful information for all parties.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Data will be shared with the Human Use and Wildlife Disturbance Model (EVOS project 98339) for their eastern Prince William Sound database. We also will provide our data to the EVOS contractor for the revision of the NOAA Environmentally Sensitive area maps that will be updated in FY99. Data will be shared with the U.S. Fish and Wildlife Service, Migratory Bird Management, for inclusion in the Alaska Seabird Colony Catalog and Database. We will also share this data with local land management agencies, including the Chugach National Forest, Eyak Corporation, the Tatitlek Corporation, Alaska Department of Fish and Game, and Alaska Department of Natural Resources. Information from this data will aid in management decisions that will increase the chances for recovery of injured species. Finally, cooperation for community involvement will be sought through the EVOS Restoration Office and the Chugach School District Youth Area Watch Program.

PROPOSED PRINCIPAL INVESTIGATORS

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4/14 fld
approved TC 12-15-98

FY 99 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999						
Personnel		$10.4						
Travel		$0.0						
Contractual		$0.0						
Commodities		$1.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$11.4		Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
General Administration		$1.6						
Project Total	$0.0	$13.0		$1.0				
Full-time Equivalents (FTE)		0.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY 99

Prepared: 4/14/98

Project Number: 99381
Project Title: Status of Seabird Colonies in NE Prince William Sound
Agency: USFS-Pacific Northwest Research Station

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 99 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1999
M. Bishop	Principal Investigator	GS-12-02	0.9	5.7		5.1
P. Meyers	Biologist	GS-09-01	1.0	3.2		3.2
Vacant	Biological Technician	GS-05-01	0.9	1.8		1.6
Vacant	Student Volunteer		0.9	0.6		0.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		3.7	11.3	0.0	
					Personnel Total	$10.4

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1999
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY 99

Prepared: 4/14/98

Project Number: 99381
Project Title: Status of Seabird Colonies in NE Prince William Sound
Agency: USFS - Pacific Northwest Research Station

FORM 3B
Personnel
& Travel
DETAIL

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

Contractual Costs:	Proposed FY 1999
Description	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed FY 1999
Description	
field supplies: aerial photos, mylar, data supplies	0.2
fuel (gasoline 250 gal@1.60)	0.4
field camp food ($45 @ 8 days)	0.4
Commodities Total	$1.0

FY 99

Prepared: 4/14/98

Project Number: 99381
Project Title: Status of Seabird Colonies in NE Prince William Sound
Agency: USFS-Pacific Northwest Research Station

FORM 3B
Contractual & Commodities DETAIL

FY 99 EXXON VALDEZ TRUSTE.. ..OUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

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

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Whaler 17'	1	USFS

FY 99

Prepared: 4/14/98

Project Number: 99381
Project Title: Status of Seabird Colonies in NE Prince William Sound
Agency: USFS-Pacific Northwest Research Station

FORM 3B
Equipment
DETAIL

Revision 7-10-98
approved TC 8-13-98

Cook Inlet Information Management/Monitoring System

Project Number:	99391
Restoration Category:	Monitoring
Proposer:	J. Hock/ADEC, C. Fries/ADNR
Lead Trustee Agency:	ADNR
Cooperating Agencies:	ADNR
Alaska SeaLife Center:	No
New or Continued:	New
Duration:	1st yr. 2 yr. project
Cost FY 99:	$335.0
Cost FY 2000:	
Cost FY 01:	$0.0
Cost FY 02:	$0.0
Geographic Area:	Cook Inlet/Prince William Sound
Injured Resource/Service:	All

ABSTRACT

This project will develop an integrated data base containing digital environmental and spatial data for the Cook Inlet watershed. The system will facilitate access to data from a wide variety of sources about the resources and services injured by the spill as well as base data sets important to understanding the environment of the watershed. This database will support monitoring, management, and restoration. The system will provide access through the Internet to the public and private sectors. Water quality data sets derived from the watershed will provide the cornerstone of this system thereby facilitating monitoring of both baseline parameters and chronic sources of marine pollution. From both public policy and natural resources management perspectives, this project will protect the governments' investment in restoration by making information derived from restoration activities and water quality monitoring programs available for management of the watershed in a manner that will promote the recovery of the injured resources and services.

INTRODUCTION

Monitoring populations of injured resources/services and effective management of their habitats that will facilitate their recovery requires a watershed-based management approach that encompasses entire ecosystems. This approach requires managers and scientists to "distinguish between natural and human-induced changes in the marine ecosystem" (Spies 1997). Pollution-caused water quality degradation, for example, could impact sensitive species or their habitats thereby exacerbating the injury and adversely affecting recovery. Toxic levels of contaminants can make fish and shellfish unfit for human consumption. Even the presence of pollutants below toxic levels can affect the public's perception of quality and safety, thereby affecting their purchasing habits for fish and shellfish. "Toxic materials can damage or stop the biological processes occurring in the aquatic ecosystems, including long-term inhibition of growth, reproduction, and migration of organisms, and have adverse effects on the rate of degradation of biodegradable contaminants" (Novotny and Olem 1994).

Although watershed-based management can be an effective strategy, implementation includes the review, integration and multivariate analysis of large volumes of data. Moreover, management and planning for development within these large areas calls for participation by federal, state and local governments as well as the public. Multiple stakeholders and scientists from many disciplines may be involved and need access to relevant data used in management and policy decisions.

This project proposes creation of an information management and monitoring system that will provide easy access to significant amounts of disparate data from a wide variety of sources about the resources and services injured by the *Exxon Valdez* oil spill as well as base datasets important to understanding the environment of the Cook Inlet watershed. The system will be a useful tool for monitoring species populations, ecological processes and predicting changes that may affect recovery of injured resources. This tool will contribute to the EPA Cook Inlet Watershed Clearinghouse and could serve as a template for other watersheds within Alaska.

The proposed project will facilitate recovery monitoring of *Exxon Valdez* oil spill injured resources/services, monitoring of water quality, tracking of pollution, and management and planning in the Cook Inlet watershed. The system will be designed around a hardware/software mix that contains a relational database and a geographic information system (GIS)[1]. It will allow users to access and review large amounts of data, assess current conditions, and analyze trends. The system will contain or be linked to datasets that provide information needed to monitor:

- recovery of injured resources/services,
- baseline physical and biological parameters,
- chronic pollution sources.

The system, which will be designed to be "user-friendly" and Internet accessible, will allow information about injured resources to be considered during resource agency permitting and regulatory functions and planning for petroleum and petrochemical development, mining, timber harvest and urban development. In addition, monitoring and data collection partnerships with *Exxon Valdez* oil spill project principle investigators, agency, industry and public stakeholders will be established through project team participation in the Cook Inlet Watershed Clearinghouse, Kachemak Bay National Estuarine Research Reserve, USGS Cook Inlet Watershed Study, meetings with EVOS project principle investigators, and other initiatives.

Potential users of the system include Federal, State, borough, and municipal government agencies, industry, scientists, the environmental community, and public oversight groups with an interest or mandate to manage the watershed. Many of these entities have already generated datasets relevant to management of the watershed that would be considered for inclusion in the system. The

[1] GIS as a Decision Making Tool; Appendix A.

Alaska Natural Heritage Program has cataloged 461 datasets relevant to Alaska watersheds. A subset of these datasets relevant to Cook Inlet has been identified. In addition, the Alaska Geospatial Data Clearinghouse has compiled a suite of GIS coverages and is currently embarked on a project to catalog existing spatial data within Alaska in cooperation with ADNR. This project will establish a National Geospatial Data Clearinghouse node at the Alaska Department of Natural Resources for state data. Other examples include: studies funded by the Trustee Council, e.g., Research & Restoration Information database, Petroleum Hydrocarbon database, Sound Ecosystem Assessment Project (SEA); ADEC's Contaminated Site Remediation Program database that contains information from more than 2,300 contaminated sites; Federal agency databases including EPA's Storage and Retrieval System for Water and Biological Monitoring Data (STORET); USGS stream flow gauging database; and Cook Inlet RCAC Environmental Monitoring Results. In addition, considerable amounts of relevant monitoring data have been and are currently being collected by various government and private sector entities for compliance with National Pollution Discharge Elimination System (NPDES) regulations and ADEC's water quality program.

Currently, there is no mechanism in place that relates these diverse datasets in a manner that gives managers a comprehensive picture of marine and upland, health, activities, and pollution issues in Cook Inlet.

NEED FOR THE PROJECT

Statement of Problem

The Cook Inlet watershed is a large and complex ecosystem containing a diverse and abundant biota subject to intense physical forces as well as increasing human influences. A majority of Alaska's population lives, works, and recreates in and adjacent to this watershed. Cook Inlet is an area where leasing, exploration, development, and production of oil and gas resources are on going and important activities. In 1996 the Minerals Management Service offered about 1.98 million acres for leasing (MMS 1996). In the same year, the State of Alaska, Dept. of Natural Resources, offered for lease approximately 1,063,423 acres of State-owned onshore and offshore land for petroleum exploration and development (ADNR 1996). Timber harvest, mining, commercial, sport, personal-use and subsistence fishing and urban development are also taking place within this watershed. This area is exceptionally important to both Alaska residents and tourists for recreation.

Communities and industry operating in the watershed generate waste streams that may be entering, degrading, and affecting the recovery of resources/services. Examples of these waste streams include used oil from vessels and other sources, bilge discharges, petroleum spills, surface runoff, sewage discharges, household hazardous wastes, and windblown garbage and/or leachate from community landfills. While some of these activities may be individually permitted, there is no system for the regional assessment of their cumulative impacts, These sources of pollution not only potentially hinder full recovery of the marine environment but could also impact the quality of the recreational experience in these areas.

Each year, industry, government, the scientific community and citizen watchdog groups generate and use large quantities of information about these areas and its resources. Typically this information is used to focus on a single resource, issue, or problem and data management techniques are used that are specific to that need. Watershed management, on the other hand, has a scope that requires evaluation of a much broader spectrum of factors within a defined geographic area. In most large, intensively used and managed watersheds, such as Cook Inlet, some stakeholders collect and analyze samples and generate data, while others rely on data to monitor resources, conduct research, or make management and policy decisions. The flow of information between these groups is often non-existent or hindered by incompatible information transfer software and hardware.

For example, information used to evaluate impacts to water quality may be derived and analyzed in a fragmentary fashion that makes a comprehensive assessment of actions affecting water resources in Cook Inlet time consuming and difficult. Projects and required individual project permits may be evaluated independently of other projects or permitted actions. This project will facilitate assessment of cumulative risk to Cook Inlet water quality by enabling an integrated analysis of disparate datasets residing in different formats.

Information and data management problems are not unique to Cook Inlet; similar issues have been recognized for other watersheds across the nation. For example, information management concerns identified as part of the Chesapeake Bay Program (SAIC 1996) include:

- Users or potential users find it difficult or impossible to access needed data. Many participants obtain and manage data for different purposes, in different formats, and on different platforms making transfer of text and data files difficult. There are no defined procedures for obtaining information.
- Documentation of data (metadata) is often insufficient or lacking entirely. There is no documentation of collection or analytical methods thereby diminishing confidence in the quality of data.
- Desired data types are not available and/or up-to-date. Data requests are not coordinated leading to duplicative data acquisition efforts.
- Available data are often too geographically broad. Information is not available at local and sub-watershed levels.
- Environmental indicators are difficult and inefficient to produce.
- There is an important unmet need for integration of different types of data in order to undertake complex analyses.

Projects that are characterized by complex data relationships, such as recovery monitoring of species populations and ecological processes, need efficient data access, integration and analysis. This is also true of ecosystem-level research projects, watershed management and monitoring, and planning and regulation of development activities conducted over large geographic areas. These activities become more efficient when relevant data is related and integrated. Managers are more likely to make decisions which benefit injured resources and services and their associated habitats if they can access and visualize the relationships between variables and proposed development. Data management increases in importance for long-term and broad-scale comparative studies in which scientists from numerous disciplines may be involved for long periods of time in addressing a complex series of questions or hypotheses, requiring increased attention to metadata, QA/QC, archiving, and methods standardization (Michener 1997).

B. Rationale/Link to Restoration

"Realistic ecological assessment" of the recovery of resources/services injured by the *Exxon Valdez* oil spill "requires long-term monitoring of salient patterns and processes at appropriate spatial and temporal scales using sound sampling design and statistical analyses" (Michener 1997). This strategy was echoed by the Chief Scientist (Spies 1997) in his description of a "...permanent, adaptive, interdisciplinary monitoring and research program that would track, and eventually help predict ecosystem changes and provide a basis and mechanism for long-term restoration, enhancement, and wise management of marine resources in the northern Gulf of Alaska."

This plan is supported by the Trustee Council's increased emphasis on "integration and synthesis of what has been and is being learned from various restoration projects and the earlier work conducted during the damage assessment phase." As Stated in the Ecosystem Synthesis section of the 1999 RFP (Trustee Council 1999): "The integration and synthesis of project results will enable

the Council, the scientific community, and the public to view the effects of the oil spill and the long-term restoration and management of injured resources/services from broad, multi-project and ecosystem-level perspectives. This will provide an improved framework for development of long-term restoration, research, monitoring, and management plans."

The contribution of the proposed project toward recovery of the Exxon Valdez oil spill injured resources and services is facilitation of management and planning within the Cook Inlet watershed. The proposed information management/monitoring system will improve access to and analysis of information on injured resources/services and their habitats in the Inlet by making Trustee Council funded research readily available to resource managers. It will facilitate access to these datasets and allow managers, scientists and planners to visualize relationships between variables, integrate datasets and project trends.

In the context of water quality management, unacceptable contaminant levels have the potential for affecting entire aquatic ecosystems including injured resources, commercial fisheries, sport fisheries and recreation. Although the project will not directly reduce marine pollution, it will provide information to help regulators control and prevent waste discharges containing toxic pollutants that can adversely affect the integrity of a waterbody and its constituent food webs.

In general, the proposed system would help achieve this strategy by:

- Tracking recovery and providing information to help minimize additional injury,
- Improving data integration and enabling complex analyses which facilitate the evaluation of cumulative impacts,
- Depicting information in GIS formats to provide clear presentation of complex issues and alternatives,
- Providing more complete information to decision-makers and the public.

The proposed information management/monitoring system will help recovery of the injured resources/services by facilitating monitoring efforts as follows:

1. Define and track baseline parameters and eventually help predict changes that would be used to manage injured resources/services and their habitats.
2. Identify and track pollution that might have adverse impacts upon injured resources/services. Most of the communities and development projects in the Cook Inlet watershed are located in coastal areas. Consequently, many of the wastes generated have the potential to enter the nearshore marine environment and affect recovery of injured resources/services.
3. Provide injured resources and services data for oil and gas leasing.
4. Help to distinguish between natural and human-induced changes in the Cook Inlet watershed.
5. Provide data to researchers who are studying ecological processes and who are modeling physical and biological factors to improve management of fishery resources in the Cook Inlet watershed.
6. Provide maps of injured species' habitats, movement corridors and environmentally sensitive areas.
7. Provide EVOS researchers and agency resource managers the ability to view and analyze multiple datasets, i.e., data layers, simultaneously through GIS capability.
8. Provide information to regulators to help them review permit applications with recovery of injured resources/services in mind.

C. Location

Design and development components of the project will take place in Juneau and Anchorage. Project benefits will be realized throughout the Cook Inlet watershed. Communities that may be affected by the project include Anchorage, Homer, Kenai, Nanwalek, Nikiski, Ninilchik, Port Graham, Seldovia, Soldotna, and Tyonek.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Despite the wealth of information from studies following the *Exxon Valdez* oil spill and other research efforts, most of the information used to plan developments and to evaluate impacts to water quality and other resources in Cook Inlet is derived and analyzed in a fragmentary fashion. Permit decisions for development projects are based upon disparate datasets that reside in formats not conducive to integrated analyses or public understanding of the issues.

To ensure that the proposed system will deliver the appropriate information in a format useful to stakeholders in the watershed, participation of municipal, environmental and private industry stakeholders will be solicited and welcomed through the existing Cook Inlet Coalition chaired by EPA. The Cook Inlet Coalition is an organization facilitated by EPA to facilitate the exchange of information and coordinate management and research efforts in Cook Inlet. Various agency processes have previously identified stakeholders in this watershed.

Although this project does not specifically address traditional ecological knowledge (TEK), TEK products that have a geo-referenced, digital database could be incorporated into the system. Data standards and QA/QC protocols will be made available to the TEK coordinator. The TEK coordinator could work with TEK projects collecting data to make researchers aware of the requirements for system compliance.

PROJECT DESIGN

A. Objectives

a) Create an information management/monitoring system.

b) Populate or link the system with data relevant to recovery monitoring of injured resources/services, water quality monitoring, management and planning of the Cook Inlet watershed.

c) Provide access, integration and analysis of information that will enhance regulatory agencies abilities to identify, track and regulate, and reduce sources of pollution that might adversely affect recovery of injured resources/services and their habitats.

d) Create access to the system for watershed stakeholders.

B. Methods

The proposed approach for creating and implementing an information management/ monitoring system includes the following steps:

Step 1:	Establish Project Team, Preliminary identification of users and data.
Step 2.	Identify user needs and functional requirements.
Step 3:	Identify and prioritize data needed to support watershed management including that related to injured resources and services and reduction of marine pollution.
Step 4:	Evaluate existing computing infrastructure.
Step 5:	Design database, GIS, and network access.
Step 6:	Develop data standards, data transfer, & QA/QC protocols.
Step 7:	Integrate existing databases and metadata.
Step 8:	Develop a long range implementation, training, and maintenance plan.

Project implementation will focus on Cook Inlet. Inclusion of the Prince William Sound watershed in the system will follow if funding becomes available.

Step 1. Establish Project Team, Preliminary User and Data Identification

The project team will consist of ADEC and ADNR staff, the technical consultant and representatives from EPA, USGS, and USFS on an as needed basis. The project team will have demonstrated expertise in database management technology, GIS, the *Exxon Valdez* restoration program, the Cook Inlet watershed, and agency responsibilities therein. The project team will initially be responsible for coordinating the User Needs Analysis Workshop, initiating contact with the contractor, identifying and contacting potential system users and other participants and compiling a preliminary list of available data. The project team will represent the project at meetings of the Cook Inlet Coalition, an existing organization that will be used to address stakeholders, project participants and other interested parties.

Step 2. Identify User Needs and Functional Requirements

The Cook Inlet Coalition met at EPA in Anchorage Alaska on January 29, 1998. At this meeting the need for a system similar to that proposed in this project was discussed as well as data needs, system functionality, and practical applications. A summary of the results of this meeting is included as Appendix B.

It is our intent to build on information gathered at the Cook Inlet Coalition January 29th meeting. During Phase I of the Cook Inlet Information Management/Monitoring Project, a comprehensive User Needs Analysis will be conducted (Schedules and Milestones, Pages 15-17).

Input will be solicited from among the following entities, which have been selected on the basis of location, land ownership, management or other responsibilities, or ongoing activities, e.g. research, in the Cook Inlet watershed:

- University (UAA & UAF)
- Government Agencies (Federal, State, Local)
- Private Sector Companies
- Native Corporations

- Environmental Organizations
- EVOS Principal Investigators.

The user base is expected to be both large and diverse. The Cook Inlet Coalition[2], a subgroup of the Watershed Working Group, has already identified numerous potential users of the proposed system. These include federal and state resource agencies, environmental interest groups, UAA, Native corporations, engineering firms, the oil and gas industry, local governments, and others. The DNR sponsored Cook Inlet Area Wide Lease Sale process identified Stakeholders, many of whom are potential users of this proposed system. Stakeholder representatives who participated in this lease sale process included: Alaska Oil and Gas Association, CIRI, commercial fishing, sportfishing, tourism, Trustees for Alaska, Alaska Support Industry Alliance, Native Tribal Councils and private land owners. Agencies and organizations that have expressed a direct interest in participating include EPA, USGS, USFS, ADF&G, MMS and the Cook Inlet RCAC.

For more detail regarding identified organizations within these categories and members of the Cook Inlet Coalition and Lease Sale Stakeholders please refer to Appendix C (Potential Users, Contributors and Other Participants). Organizations will be contacted and invited to participate in this project. The project will be described and an expression of interest requested. It is expected that a meeting of the Cook Inlet Coalition will be held prior to the User Needs Analysis Workshop to introduce the project and encourage participation. Follow up to the initial contact will be based upon the response to the invitation to participate in the project and attendance at Cook Inlet Coalition meetings.

Subsequently, a two-day User Needs Analysis Workshop will be held in Anchorage, facilitated by the consultant, to solicit input from potential users on available datasets, data priorities, needs, functionality, maintenance, hardware/software and data standards. A sample outline providing a more detailed description of the structure/goals/output of the user requirements workshop is included in Appendix D (Sample Outline for User Requirements Workshop). The User Needs Analysis Workshop will be a highly structured, facilitated session that follows a systematic approach to identifying user needs. Results of this workshop will be summarized and submitted to participants for their review and comment. Based upon the results of this workshop and other information from the user community, an initial set of system specifications for the Cook Inlet information management/monitoring system will be prepared. These specifications will address data management considerations, hardware and software requirements, data standards, user interface, maintenance, and initial functionality of the system.

Step 3. Identify And Prioritize Data Needed To Support Watershed Management Including That Related To Injured Resources And Services And Reduction Of Marine Pollution.

Datasets will be identified by relative priority in the User Needs Analysis. The project will focus on making the highest priority information available first to the user community. This process will also be used to identify incomplete or missing datasets and those that need to be converted or reprocessed. The Project Team will evaluate data sources for ease of use and relevance to the project. Data gaps will be identified with suggestions for filling these gaps. A revised, prioritized list will be developed which takes into account:

- status of data,
- importance of data to success of the project,
- accuracy,
- scale,

[2] Cook Inlet Coalition Attendees: EPA, ADF&G, UAA, USGS, BLM, UAF Coop Extension Service, Nature Conservancy, AK Natural Heritage Program, ADEC, CIRCAC.

- currency,
- QA/QC,
- format,
- organization of the data,
- integrity of the data,
- adherence to data standards,
- duplication and redundancy,
- resources needed to acquire the data,
- effort required to incorporate data into system, and
- update requirements.

Some of the data analysis has been completed. Preliminary identification of datasets has been done by DEC through contract with ESRI[3] and EPA through a contract with the University of Alaska, Anchorage[4] (Reference Appendix E). This information will provide the basis for discussions regarding available data during the User Needs Analysis Workshop. A final prioritized list of datasets will be shared with project participants and included in the system design document.

Regional base data layers[5] that are readily available include:

Roads
Populated Places
General Land Status
Legislatively Designated Areas
Conservation System Unit Boundaries
Alaska Coastline
Major Rivers
Rivers
Lakes
Glaciers
Kenai Peninsula Land Status and Easements
State Boundary
Borough Boundaries
City Locations
Road Networks
Railroad Network
Hydrography

A compilation of available data will be produced by this project at the end of Phase I. This compilation may not conform to FGDC metadata standards referenced in Step 6. However, information included in this compilation will include a description, format, availability, contact information and any restrictions or limitations associated with the data.

All user needs cannot be met by this project due to limiting factors such as funding; quality, availability, and compatibility of data.

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[3] Environmental Systems Research Institute, "Geographic Information Systems User Needs Assessment Composite Report – Final," Alaska Department of Environmental Conservation, Juneau, AK. 1994

[4] Boggs, K. Et al., "Information Management for Use in Watershed Planning for Alaska," Alaska Natural Heritage Program, University of Alaska Anchorage, Anchorage, AK, 1997.

[5] LRIS, Division of Support Services, Alaska Department of Natural Resources. "Geographic Information Systems Database Summary." 1995 and http://www.dnr.state.ak.us/ssd/gisdata/index.htm.

Step 4. Evaluate Existing Computing Infrastructure

Hardware, software and network configurations used in the system will be chosen on the basis of user needs, capability, and compatibility with existing systems. Much of the data accessible through the system will be referenced geographically. A geographic information system (GIS) will be used to visualize these data and discover new relationships, especially as they relate to detection of cumulative impacts, conduct spatial analyses using analytical algorithms, and generate maps that are easily understood by decision makers and the general public. Various database and GIS options will be considered that embody needed capacity, compatibility, technical support and user-friendliness.

Most State and Federal agencies are using either Arc/Info or ArcView or both to view and manage geographic information. It is expected that ArcView will be used as a prototyping tool. However, various tools including Map Objects and Internet Map Server (both developed by ESRI) as well as a variety of programming languages are available for internet deployment and the tool or tools of choice will depend upon results of User Needs Analysis, beta testing of the prototype, and further analysis of user functionality requirements.

Step 5. Design Database, GIS and Network Access

Once hardware and software requirements are identified, an object based design effort will document the essential system components. A prototype will then be developed based upon specifications delineated in the User Needs Analysis, prioritized list of datasets, the system design, and the recommended hardware software, and network configurations.

The design and development of the prototype will include a review and evaluation of systems that have been created to meet similar needs. This review will include systems developed for the Chesapeake Bay (Chesapeake Information Management System), states of Montana (Montana View) and Colorado (Colorado Watershed Data Integration System), and the country of Jordan (Water Quality Improvement and Conservation Project, Water Monitoring System). This review and evaluation will also include a suite of EPA databases including the STORET Modernization Effort, the Environmental Monitoring and Assessment Program (EMAP) Phase II, the Spatial Data Library System (ESDLS), BASINS (The Better Assessment Science Integrating Point and Non-point Sources), and ENVIROFACTS.

It is expected that the prototype will contain a relational database designed to accommodate tabular data associated with permitting and regulatory activities. This component of the project will be developed in close coordination with ADEC regulatory staff in order to capture all pertinent water quality information. The relational database will be linked to a GIS decision making tool utilizing base map information to depict relationships between physical, biological, and cultural features of the watershed. The initial prototype will be populated with a subset of readily available datasets from the prioritized list of datasets.

The prototype will integrate the GIS and relational databases although it will not contain all datasets. Additional datasets will be identified and evaluated on an "as needed" basis. The prototype and needs analysis will provide the basis for a detailed full system design document.

The prototyping cycle is an iterative process that introduces the prototype to project participants and allows the Project Team to observe use patterns and solicit additional input from potential users. Initial review of the prototype will result in a preliminary analysis of training and access needs for various user groups. The development and evaluation of the prototype will require numerous reviews by project participants. Throughout this iterative process, deficiencies will be identified and enhancements incorporated.

The prototyping process will include criteria for measuring success. Some of the criteria or evaluation questions include:

- Can the information system effectively and efficiently address Cook Inlet monitoring/management goals?
- Is a geographically distributed database feasible in the Cook Inlet area where there is a multitude of users and contributors operating under different circumstances?
- Is the system feasible given the hardware, software and telecommunications capabilities of Cook Inlet stakeholders?
- Is the system easily accessible to users?

Results of this prototype evaluation will be used to refine the system and produce specifications for implementation of a full data integration system. The final product, which will be based on the prototype and its evaluation, will enable users to access data through the Internet; browse, select, integrate, and analyze different types of data from disparate sources including geo-referenced spatial data. Part of the design and development process will be the creation of a user-friendly, menu driven graphical user interface.

The Internet is currently the preferred means for distributing information and data within State and Federal agencies working on this project. For example, the DNR Database Summary posted on DNR's web pages[6] provides public access to metadata and a process for ordering data. The Alaska Geospatial Data Committee Home Page[7] provides access to metadata and data on line. DNR is currently implementing a State Geospatial Clearinghouse project that will provide additional capacity for the discovery and distribution of data and metadata on line.

The system must also be able to access external sources of information. Internet connectivity will allow access to external databases including the EPA STORET database, USGS Stream Flow data and the EPA Envirofacts database. Once this connectivity is in place linkage to other systems such as SEA is desirable and possible. Connectivity to external information reduces the amount of storage capacity required at the user's desktop and reduces costs associated with maintenance and updating of data. Various tools including Map Objects and Internet Map Server (both developed by ESRI) as well as a variety of programming languages are available for internet deployment and the tool or tools of choice will depend upon results of beta testing of the prototype and analysis of user functionality requirements. Compatibility with the ARC/INFO and ArcView data format will be required.

It is desirable for the project to provide access to the following external water quality datasets:

a) EPA STORET (surface and ground water data) (5936 surface water stations and 2410 ground water stations in Alaska)

b) STOREX: This is program on the EPA mainframe that extracts data from STORET and builds three comma delimited ASCII text files, which are compatible with ArcView. The program extracts data by HUC. The three files listed below are then downloaded from the mainframe and loaded into ArcView and converted into shapefiles and dBase files.

c) USGS CD-ROM DDS-37: Data from Selected U.S. Geological Survey National Stream Water-Quality Monitoring networks (13 stations in Alaska)

d) EPA Permits Compliance System: Municipal and Industrial discharge limits and discharge monitoring reports) (574 Alaska facilities in PCS)

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[6] http://www.dnr.state.ak.us/ssd/gisdata/index.htm

[7] http://agdc.usgs.gov/

e) PCSEX: This is a program on the EPA mainframe program that extracts all data from the Permits Compliance System. Three comma delimited ASCII text files are generated. These files are downloaded from the mainframe, loaded into ArcView, and converted into shapefiles and dBase files.

f) USGS Water Resources Division web site: Stream Flow data will be extracted and stored as dBase files with Flow station header stored as a point coverage of gage locations) (450 stream gages in Alaska).

g) Envirofacts database: 1848 regulated facilities in Alaska.

h) BASINS: The Better Assessment Science Integrating Point and Non-point Sources system that integrates a GIS, national watershed datasets and state-of-the-art watershed assessment and modeling tools.

Step 6. Develop Data Standards, Data Transfer & QA/QC Protocols

Based upon user needs and input, project staff will adopt standards for process and content as required to meet user needs. These standards will set a target for data generators to meet. Current standards will be used where they already exist. Standards will be communicated via technical reference or the project data dictionary.

Although a variety of standards exist, all potential users and contributors have not adopted a comprehensive standard. Identification and adoption of standards by all users is a contentious issue because it affects all levels of data collection, analysis and reporting. Since data brought into this system will come from a myriad of sources it is important to develop project specific standards that will facilitate access and use of the system. Data standards will include basic geospatial, temporal, and name standards and, in the case of chemical data, the point of collection in time and space and the analytical methods used.

Geospatial standards will be discussed at the User Needs Analysis Workshop and will likely conform to commonly used statewide practices. DNR, for example, maintains all geospatial data in a format compatible with ARC/INFO, UNIX software system published by Environmental Systems Research Institute of Redlands, California. Data for statewide themes and section grids are stored in Alber's Equal Area Conic Projection with a central meridian of 154 degrees. Other parameters are specified with each coverage. Data provided at the 1:63,360 quad level for hydrography are stored in the respective state plane coordinates for that quad. All data will be referenced (Map Projection) in the North American Datum, 1927 (NAD27) unless otherwise noted in the metadata. These standards have evolved over time and are the basis for the routine exchange and distribution of data to other agencies, municipalities, and the public upon request. It is expected that for this project geospatial data will be stored in a format accessible by ArcInfo or ArcView including shapefiles, dbase files, ARC/INFO coverages, supported image formats (GIF, tif., etc) and ASCII text files. Related databases will, by virtue of ArcView and ARC/INFO specifications, conform to the Open Database Connectivity (ODBC) standard. This includes relational databases developed and maintained in applications such as Informix, Oracle, Microsoft Access, Microsoft SQL Server etc. It is expected that ArcView may be used as a prototyping tool because of its widespread use within the state.

FGDC (Federal Geographic Data Committee) standards will be used for metadata. See *Content Standards for Digital Geospatial Metadata Workbook*[8] for details. A project goal is that FGDC compliant metadata accompany all data included in this application. This will assure compliance

[8] Federal Geographic Data Committee. "Content Standards for Digital Geospatial Metadata Workbook (Describes the June 8, 1994 version of the metadata standard) Workbook Version 1.0, March 1995.

with Internet search and discovery standards for geospatial data. Water quality data will be documented in this format for consistency.

A data dictionary will be developed that will summarize all of the data standards utilized by the project. A data dictionary is a file that details the attributes for a database and individual data elements and defines their relevant characteristics. The data dictionary will facilitate consistent reporting, nomenclature for transfer of data and definitions among disparate data providers.

The degree to which datasets conform to a set of standards depends in part upon how tightly integrated the data needs to be with the delivery system. The higher the level of system integration, the greater the need for a single, fixed set of format standards. If one of the goals is to make key datasets more available for analysis, this information may remain largely unmodified. The focus of the effort is placed upon knowledge of the data, ease of access, and a means for maintaining currency. System requirements will be addressed in the needs analysis and project design.

Step 7. Integrate Existing Databases and Metadata Files

Primary and high priority datasets that are in compliance with documentation and process standards will be loaded into the system. Other compatible datasets, accompanied by metadata files, will be linked to the system as time and budget constraints allow. Updates to existing datasets and new datasets will be evaluated for compliance with standards and brought into the system over time.

Project participants recognize the complexity of data management tasks including data cleanup, QA/QC, conversion, integration and documentation. These tasks are elements of the overall approach for incorporating required datasets into the system. An accurate assessment of the scope of work and resources required to carry out data conversion first requires identification, evaluation, and prioritization of essential datasets, and establishment of data, and documentation standards. It is reasonable to expect that a substantial effort, 60% - 80%, may well be invested in these activities. Data priorities must guide the conversion effort within budgetary constraints. The estimated budget provides conservative controls on a potentially vast undertaking.

Step 8. Develop a Long-Range Implementation Plan

ADNR and ADEC have the ability to maintain the system into the future. Considerable breadth exists within the Departments and the Department of Natural Resources has an extensive computer support system in place. DNR's Division of Information Services includes computer repair technicians familiar with both hardware and software on a variety of platforms (UNIX, Windows, Macs), programmers, systems administrators, GIS experts, and database experts.

DNR manages 86 million acres of uplands for diverse uses as well as the State's tidelands. Its land status database is presently being converted from an older computer drafting system to a GIS using open networks and distributed processing. This system is being tied to the department's tabular, mainframe Land Administration System (consisting of databases and over 2500 computer programs) in order to provide additional decision making tools to land managers. The scope of this project is quite large and the breadth of staff support required to complete this task quite extensive. This capacity is available to DNR principal investigators working on this project. In addition, the department has an extensive data distribution system in place and regularly distributes data to the public. MOUs are in place with a variety of governmental organizations to facilitate the exchange of data on a regular basis.

DEC has committed to the long-term maintenance of the information management/monitoring system subsequent to completion of this project. The DNR Commissioner has committed the agency to maintaining the Cook Inlet application and the associated GIS coverages supporting this application as part of their on-going role in maintaining a National GeoSpatial Data Clearinghouse node at ADNR. Staff have been identified to work directly with the contractor to ensure that a

complete understanding of the system resides with the agencies and that long-term maintenance requirements are reasonable.

A plan will be developed for maintaining the system and transferring, relating, integrating and updating data over the long run. The plan will include staffing, hardware and software, application and networking recommendations. Deliverables associated with Step 8 include Project Design Document, Training Manual, and User's Guide.

C. Cooperating Agencies, Contracts and Other Agency Agreements

The Alaska Department of Environmental Conservation and the Alaska Department of Natural Resources will be jointly responsible for project implementation, drawing upon the expertise within each agency. Both agencies will work cooperatively with technical consultants in the areas of hardware and software upgrade requirements, data acquisition and translation support, application development, and staff training. ADEC will focus primarily on water quality issues and database design while ADNR will lend assistance in the areas of geo-referenced data issues, application development, and resource management issues.

ADEC will conduct an in-house review of other agencies' water quality data inventories in addition to ADEC's Data Repository Analysis (Resource Data, Inc., 1997). ADEC will develop QA/QC protocols and data collection standards associated with water quality data. ADEC will assist in the design and development of the relational database engine.

In keeping with its objective, to develop a State wide watershed approach, ADEC will operate and maintain the information-monitoring system subsequent to completion of this project. This long-term commitment will allow the Trustee Council, the scientific community, resource managers and the public to access information on the recovery of injured resources and services.

ADNR is currently implementing an "Alaska State Geospatial Clearinghouse" funded with a grant from USGS. The Clearinghouse project will establish a National Geospatial Data Clearinghouse node at the Alaska Department of Natural Resources, which will allow for the development of an electronic pathway to meet public and inter-agency demands for geospatial data. Data will be documented according to the FGDC requirements to ensure consistency and discovery on line. The ADNR Clearinghouse project focuses on state and local data and will complement the Alaska Geographic Data Clearinghouse site developed and maintained by USGS.

As a result of the clearinghouse project ADNR will be able to facilitate the identification of available data, encourage the efficient use of State and Federal resources in order to avoid duplication of effort, and ensure that data, as it is incorporated into this project, is both useful to and consistent with other Statewide efforts. ADNR will be responsible for evaluating and determining usefulness of related GIS data, and will take the lead in making data usable to the GIS application developed as a result of this project. ADNR will ensure that the GIS interface is compatible with other State GIS projects, software and data collection efforts. ADNR will develop data and data transfer standards for this project, and evaluate existing hardware and software configurations in terms of capability, capacity, and compatibility. ADNR will have primary responsibility for the GIS component of this project.

As a collaborator on the project, EPA will provide technical assistance in system design as well as access to the EPA Contractor responsible for designing similar systems in other States. As part of the overall EPA and ADEC objective of a State wide watershed approach, emphasis will be placed on assuring that the project is complementary to the concept of a State-wide "Environmental Information Clearinghouse." EPA will also serve as the facilitator for involvement in the project of other Federal natural resource agencies and will contribute its organizational and leadership skills to ensure continued Cook Inlet Coalition involvement. EPA has also agreed to make all of its Water Quality and Permits databases available to the Cook Inlet Management/Monitoring System.

The US Forest Service will provide technical assistance in project design in order to ensure agency concerns and project compatibility issues are addressed. USFS will contribute staff resources as needed to address management and scientific needs of the agency in the development of this project.

A consultant will be utilized to facilitate creation of a database structural framework and integration of water quality data, EVOS related data, environmental data, cultural and physical features into a GIS-based decision making tool with the potential for Internet access. The technical consultant is key to the success of this project. We are working with EPA and propose to utilize a National Level of Interest Contractor under contract to EPA with extensive experience in projects of this nature. Similar projects have been implemented by this contractor in Colorado, Montana, Chesapeake Bay, and Jordan.

The contractor will be used to facilitate the User Analysis, evaluate user community input and develop a recommended system specification. The contractor will develop the Cook Inlet prototype with assistance from DEC and DNR staff who have experience in data management in Alaska. The contractor will perform most data integration, application development, and user interface development. This strategy will ensure that contractual dollars are spent on areas where the contractor already has extensive experience, enabling us to benefit from knowledge and products they have developed elsewhere. This strategy will also ensure that project development goes beyond a single agency approach. Alaska agency staff familiar with the data, its limitations, location, and structure will be responsible for most routine data management tasks as well as local coordination and dissemination of information. Agency staff will also be closely involved in application development, data integration and user interface development in order to ensure that maintenance of the system can be accomplished without contractor support. Agency staff has experience in training GIS users and will be utilized for this portion of the project.

SCHEDULE

Phase I

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

October 1998	Identify User Community, Establish written contact. Coordinate with EPA to schedule preliminary Cook Inlet Coalition Meeting to introduce project, encourage participation and identify additional members of User Community. (Step 1, page 7)
October 1998	Develop cooperative agreement with EPA. Initiate Contractor Contact, Identify scheduling, facility and program needs for User Needs Analysis Workshop. Assemble comprehensive list of available datasets for distribution to User Community for review prior to User Needs Analysis Workshop. (Step 3, preliminary, page 8-9)
November 1998	Conduct User Needs Analysis Workshop facilitated by Contractor. (Step 2, page 7-8)
December 1998	Results of User Needs Analysis Workshop due from contractor. a) Prioritized list of data sources and strategy for data acquisition. b) User Needs Analysis. c) Systems evaluation of hardware and software. d) Prototype System specifications. e) System standards.
January 1999	Cook Inlet Coalition meets to review results. (Steps 2, 3, 4, partial 6, pages 7-13)

January 1999	Begin development of Prototype for Cook Inlet by contractor. Initiate data acquisition, manipulation, QA/QC, conversion, by staff. Compile data inventory by staff (Steps 5, 6, 7, page 10-13)
Ongoing	Data acquisition, manipulation, QA/QC, conversion, integration. (Step 7, page 13)
July 1999	Prototype evaluation initiated through meeting of Cook Inlet Coalition. Initiate agency staff training for prototype evaluation. (Steps 5, 6, revisit Step 2, pages 10-12, 7-8)
September 1999	Prototype evaluation continues. Development of System Specifications for implementation of Phase II. a) System Specifications. b) System standards. c) Long term maintenance. d) Prioritized list of data sources and strategy for data acquisition. e) Data management.
October 1999	Cook Inlet Coalition meets to review Full System Specifications. (Step 8, page 13-14)

Phase II *DRAFT*
Measurable Project Tasks for FY 2000 (October 1, 1999 -September 30, 2000)

December 1999	Implementation of System Specifications delivered in Phase I. Initiate integration of prioritized databases and associated metadata. Continue agency staff training as a prototype evaluation tool. (Steps 5, 6, 7, pages 10-13)
August 2000	Integration of databases completed. Data documentation, data dictionary, completed. (Steps 5, 6, 7, 8, pages 10-14)
August 2000	Develop User's Manual. (Steps 5, 6, 7, 8, pages 10-14)
August 2000	Training and public outreach. (Steps 5, 6, 7, 8, pages 10-14)
September 2000	Deployment of Cook Inlet System

Project Milestones and Endpoints

Phase I (FY 99 October 1, 1998 to December 1, 1999)

October 1998	Schedule meeting of Cook Inlet Coalition to prepare for User Analysis Workshop.
November 1998	User Analysis Workshop.

December 1998 User Analysis Complete.

December 1998 User Analysis Complete.

January 1999 Cook Inlet Coalition Review of User Analysis.

July 1999 Cook Inlet Prototype available for evaluation.

December 1999 Cook Inlet System Specifications Complete.

Phase II *DRAFT* (FY 2000 October 1, 1999 to September 30, 2000)

June 2000 Integration of databases and metadata.

August 2000 User's manual and database documentation.

August 2000 Staff Training and public outreach.

September 2000 Cook Inlet System available for use.

Completion Date September 30, 2000.

Deliverables Phase I (FY 99, October 1, 1998 to September 30, 1999)

1. User Needs Analysis
    - Prioritized list of data sources, strategy for acquisition
    - Identification of User Needs, practical applications
    - System evaluation, hardware and software
    - System standards

2. Identification and Prioritization of Datasets
    - Compilation of available data, including description, format, availability, currency, originator, contact information.
    - Compilation will not be FGDC compliant but will be available for posting on the internet if desired.

3. Prototype
    - Cook Inlet Information System, Beta Version
    - Installation Instructions
    - Preliminary User Guide
    - Evaluation Survey

4. Cook Inlet System Specifications
    - Technical Approach
    - Data Analysis
    - Design
    - User Guide
    - Recommendations

NORMAL AGENCY MANAGEMENT

Resource agency management mandates in the Cook Inlet watershed do not specifically address recovery monitoring or management of injured resources/services or their habitats. Only projects that have been funded by the *Exxon Valdez* Oil Spill Trustee Council have focused on injured resources and services as an objective. Although pollution tracking, permitting, and regulatory activities are normal agency management activities, they are not carried out with the benefit of research specifically addressing injured resources and associated services.

Agency regulatory actions are generally focused on single resource management strategies or individual project implementation. These actions may lack a coordinated, comprehensive ecosystem approach. Ecosystem or watershed-level management requires access and integration of a diverse array of data from disparate sources. In order for agencies to consider the cumulative impact of management and regulatory actions on injured resources and services and their associated habitats, the agencies must be able to integrate and utilize the data and information collected about these resources. Agencies do not normally consider, or have the capability to consider, the impact of management and permitting decisions on injured resources and services.

A coordinated, comprehensive watershed-level approach will facilitate effective management. It will encourage and facilitate the implementation of cost-effective solutions that are beyond the capability and capacity of individual agencies and communities. As a result, environmental stress and further degradation of existing services will be diminished, resulting in less injury to local resources important to the livelihood of these communities. A cooperative effort between the agencies and communities will improve the management of water resources and facilitate recovery of injured resources.

A comprehensive approach to restoration of injured resources/services with habitats in Cook Inlet would include not only affected species populations, but also consideration of relevant ecological elements on a watershed scale. From a technical perspective, management at the watershed level allows for evaluation and control of pollution and development impacts that would affect recovery of injured resources/services.

The proposed project would provide a tool enabling regulators, managers and planners to affect a watershed approach to management. For example, ADEC has the statutory obligation to evaluate waste stream impacts to a receiving water through the certification of National Pollution Discharge and Elimination System (NPDES) permits, administered by the EPA. This evaluation requires information from a variety of sources in addition to that provided by an applicant seeking a discharge permit or other activity that might affect water quality. Moreover, this information must be made available to the public during the permit application and review process. At the present time, there is no database that contains or links the datasets that are needed for this evaluation and review. Implementation of the system would help both the public and resource agencies answer questions such as:

- What is the condition of the surface, ground, estuarine, and coastal waters?
- Where, how, and why are water quality conditions changing over time?
- Where are the problems related to water quality? What is causing the problems?
- Are efforts to prevent or remediate problems working effectively?
- Are water-quality goals and standards being met?

In the case of a new discharge permit application, the system proposed by this project would allow DEC staff to access appropriate base datasets, the EPA STORET database, the USGS water quality monitoring network, and relevant USGS stream gages. In addition, these data as well as the DEC analysis could be made accessible to the public. DEC reviewers could also determine, by checking

on-line datasets, whether or not the proposed discharge would have impacts upon recovering populations or their habitats. The system would also allow DEC or EPA to build and use models to assess the waste-assimilative capacity of the receiving waters and the impact of pollution inputs on wetlands and injured resource habitats.

In the case of land managers responding to requests for permits in Cook Inlet tidelands, as required by statute, the system proposed by this project would allow staff to review existing human uses in the area as well as information concerning habitats of injured resources and services. A decision could be made that factors in the potential impact such an activity could have on injured resources or services. If the location requested by the applicant is deemed unsuitable, state law requires that an alternative must be located or proposed. The proposed system could be used to direct permitting toward less sensitive areas. At present this analytical capacity does not exist.

Internet access to the data used by agencies for permitting and planning decisions would allow the public to become better informed and thereby better able to comment and provide input to federal and state decision-makers. At the present time it is very difficult for the public to locate and access these datasets even though the agencies are obligated to make them available, i.e. FOIA requests.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will be integrated with the Restoration Effort by involving principal investigators and EVOS data managers in the User Needs Analysis. Key Principal Investigators will be surveyed and asked to evaluate and test the system for usefulness and the ability to accommodate results of their research. It is extremely important that key information derived from EVOS studies be included in this system if end users are to be able to include information relative to injured resources and services in their decision making processes. In addition, extensive coordination with SEA, APEX and NVP, will avoid duplication of effort and ensure that pertinent data and information from those projects is incorporated into this system.

PRINCIPAL INVESTIGATORS

Jeff Hock

Jeff Hock has a Bachelor's degree in Environmental Sciences from the University of Virginia with significant coursework in civil engineering. He has been employed in various capacities with the State of Alaska since 1975 in both the Alaska Department of Fish & Game and the Department of Environmental Conservation. As an Ecologist with the ADEC Division of Environmental Quality he has been involved in the design and implementation of a variety of monitoring projects and has extensive experience in quality assurance, project plan development and review, and sampling methodology. He has been instrumental in exploring and implementing new technologies within the Division of Environmental Quality including, modeling software, rapid bioassessment protocols, satellite telemetry, global positioning technology, geographic information systems, and automated water quality data acquisitions and telemetry systems. Mr. Hock's responsibilities also include developing and implementing ADEC's watershed framework by working with local stakeholders, and participating on various statewide water quality planning committees.

Russell Kunibe

Russell Kunibe has an MS and BS in Physiology from UC Davis and has 9 years of experience with the Department of Environmental Conservation both as an Environmental Specialist and as an Analyst Programmer. He is currently responsible for the DEC Web site and is the department GIS expert. He has served as the department representative to the Statewide GIS committee and

Webmasters committee. He has managed the Spill Prevention and Response Division's data management tasks.

In addition Mr. Kunibe has a working knowledge of the Cook Inlet and Prince William Sound areas. He successfully owned and operated his own commercial fishing, boat charter, and dive shop businesses in Homer prior to the *Exxon Valdez* Spill. During the response to the *Exxon Valdez* Spill, Mr. Kunibe managed the DEC Field Office in Homer.

Patty Bielawski

Patty Bielawski has extensive experience as an environmental scientist specializing in facilitating resolution of natural resource program and policy issues; permitting; and analysis of environmental and resource legislation and regulation. She has worked in the private sector as a consulting environmental scientist (BPX. AOGA) and in the public arena as a special assistant to the Commissioner of the Department of Natural Resources (present) and Senior Project Review Coordinator for the AK Division of Governmental Coordination. Ms. Bielawski has a B.S. in Biology from the University of Santa Clara, with specialized training in Environmental Regulation and Legislation, Resource Conservation and Recovery Act, Hazardous Waste Bioremediation, and North Slope Terrestrial Studies.

Her current position as Special Assistant to the Commissioner of the Department of Natural Resources has involved extensive interagency project management efforts and will be invaluable in the implementation and coordination of the scientific aspects of this project.

Dorothy Mortenson

Dorothy Mortenson has fourteen years of cartographic and geographic information system experience. She is currently the GIS Project Manager and a senior member of the Technical Information Services staff at the Alaska Department of Natural Resources, and is responsible for all aspects of GIS services for the Exxon Valdez oil spill mapping and analysis. Ms. Mortenson has piloted projects to improve data quality, efficiency, and accessibility. Ms. Mortenson received the "Director's Technical Contribution Award" from the Environmental Protection Agency, 1989 and has a Bachelor of Science degree in Geography with an emphasis on Cartography and Remote Sensing, Oregon State University, 1986.

Ms. Mortenson has been instrumental in creating an ADNR GIS User's Group and has actively participated in statewide State Federal Data Clearinghouse efforts and projects. She is currently involved in the implementation of the Alaska State Geospatial Clearinghouse, an NSDI Competitive Cooperative Agreement with USGS. This project will establish a National Geospatial Data Clearing-house node at the Alaska Department of Natural Resources. This project will allow for the development of an electronic pathway to meet public and inter-agency demands for geospatial data. Data will be documented per the requirements of the FGDC "GEO" content standards to assure discovery. This node will complement the NSDI clearinghouse site established at the Alaska Field Office of the US Geological Survey by focusing on state and local data. Ms. Mortenson's experience in this project will prove invaluable as the team seeks to identify existing datasets, avoid duplication of effort, and leverage ongoing data acquisition, and manipulation efforts.

Kelly Zeiner

Kelly Zeiner has a Master of Science in Spatial Information Science and Engineering from the University of Maine, Orono, and a Bachelor's Degree in Management Information Systems from Northeastern University, Boston, MA. She has extensive experience with Arc/Info, ArcView, and a variety of programming languages (AML, DIBOL, COBOL, BASIC) and computer operating systems (UNIX, Windows, Macintosh). As part of her graduate program she designed and taught

a series of 3 day ArcView/Avenue course exercises and lectures at the University of Maine. This experience is invaluable in communicating with potential system users, managers, and scientists and interpreting and understanding their information and analytical needs.

Ms. Zeiner has been employed at DNR since 1992 and has extensive experience with *Exxon Valdez* Oil Spill data and project demands. Final products of her work on EVOS related projects include applications ("EVOS Oil Spill Research & Restoration Information Project"), maps, slides, and reports on analyses performed. Ms. Zeiner has also designed and built a prototype application using ArcView 3.0 for viewing and querying ADNR's statewide parcel-level database, including an SQL connection to a massive land records database. In addition, Ms. Zeiner has designed a prototype application based on the State of Florida's Oil Spill Contingency Planning tool using ArcView 3.0 adapted for use in the State of Alaska. The contingency planning prototype has focused on the Kodiak region.

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APPENDIX A
GIS as a Decision Making Tool

A GIS or Geographic Information System uses computers. software and networks to present information useful for making land use decisions or other activities such as supporting research, land planning, and property administration. It is a very useful tool for displaying and communicating large quantities of data covering a large geographic area such as Cook Inlet. One common GIS definition is:

> "An organized collection of computer hardware, software, geographic data and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information."

A GIS typically links data from different sets or databases using geography as the common thread. Information can be linked if it relates to the same geographic area. While many individual datasets can present a picture of a certain activity or situation, combining datasets allows for more comprehensive analyses.

A GIS can generally address five generic questions:

- What is at.....?,
- Where is it?,
- What has changed since.....?,
- What spatial patterns exist?, and
- What if?

All geographic information systems incorporate a database management system. A well-designed GIS can support a number of different views to satisfy many needs. The software allows the developer to create many different user views of the data that reside within or are accessible to the database. This allows the user to view complex inter-relationships between variables graphically. All users share the common database, viewing it in such a way as to meet their own particular needs.

There are many benefits of a shared information system. Users of information can view a variety of themes simultaneously to discover relationships, dependencies, and conflicts. Agencies functioning in regulatory, managerial or permitting capacities can utilize this system as well as proponents and opponents of a particular action. For example, should the state propose a lease sale in Cook Inlet, lease administrators could look at resource data, physical environmental data, existing infrastructure and existing oil and gas developments in order to ascertain whether or not a opening a particular area presents a potential problem from an environmental standpoint. Looking at relationships of various datasets such as critical habitat areas, breeding areas for particular injured resources, existing oil and gas development, or water quality data may indicate that a particular area is unsuitable for a lease sale. Proponents of the sale would also be able to view the same data, discover the same relationships, and develop arguments in support of a particular lease sale. Trends may become evident over time as new information or data is added to the system. Conflicts can be identified, and negotiations, mitigation, or alternatives considered. Permitting and resource development activities can be modified or mitigated to take into account trends or areas of concern identified by viewing spatial relationships of different datasets.

Goals of this project and other ongoing state GIS efforts are to:

- Organize data so that different users can access the same datasets.
- Maintain data that supports many different uses – present and future.
- Support multiple user views.
- Maintain data independent of any specific application.

The benefits of a shared database are many:

- Increases the flexibility of data retrieval, analysis, and production.
- Increases the likelihood of users developing additional applications.
- Distributes the cost of data capture, storage, and use.
- Facilitates transactional maintenance of the database.
- Minimizes redundancy.

APPENDIX B
Cook Inlet Coalition Meeting January 29, 1998.

The Cook Inlet Coalition met at EPA in Anchorage Alaska on January 29, 1998. At this meeting the need for a system similar to that proposed in this project was discussed as well as data needs, system functionality, and practical applications. The following is a list of the data needs discussed at this meeting:

- Water quality data: physical, chemical, biological
- Sediment quality data
- Soils
- Tissue data
- Land Use/Land Cover
- Stream Flow
- Location of NPDES, RCRA, TRI. and contaminated sites
- Locations of pollution sources
- Fisheries data
- Salmon spawning areas
- Biologically sensitive areas
- Habitat identification
- Animal and plant abundance and distribution data
- Infrastructure in Cook Inlet and onshore
- Satellite Imagery
- Climatological conditions
- Bathymetry, currents, tides
- Bibliography
- Educational tools

System functionality was prioritized as follows:

- Search and browse capability for metadata and the data itself.
- Ability to download data
- GIS and mapping capability
- Data analysis and mapping functionality

System functionality and use requirements discussed include:

- Permitting
- Planning and Decision Making
- Funding
- Modeling
- Research
- Leasing
- Assessment
- Litigation

APPENDIX C
Potential Users, Contributors and other Participants

The following interest groups and potential users have been identified for the Cook Inlet Watershed. Representatives of these interests will be invited to participate in the User Needs Analysis Workshop. The Cook Inlet Coalition and the Cook Inlet Area Wide Leaseholder Stakeholders provide a starting point for the identification of specific individuals.

IDENTIFIED INTEREST GROUPS

University

- University of Alaska Anchorage
  Alaska Natural Heritage Program
- University of Alaska Fairbanks
  Kasitsna Bay Field Station
  Sea Grant Marine Advisory Program

Government Agencies (Federal, State, Local)

- Federal
  1) USGS
  2) EPA
  3) USFS
  4) MMS
  5) USFWS
     Kenai National Wildlife Refuge
     Alaska Maritime Wildlife Refuge
  - National Park Service
  - DOI
- State
  - DEC
    Division of Air and Water Quality
    Division of Spill Prevention and Response
    Division of Environmental Health
    Division of Statewide Public Service
  - ADF&G
    Division of Commercial Fisheries Management & Development
    Division of Sportfish
    Division of Habitat and Restoration
    Division of Subsistence
    Division of Wildlife Conservation
  - DNR
    Division of Land
    Division of Oil and Gas
    Division of Parks
    Division of Forestry
    Division of Mining and Water
- Local
  - City of Homer
  - Seldovia
  - City of Kenai
  - Kenai Peninsula Borough
  - City of Soldotna

Private Sector Organization

- Pratt Museum
- Center for Alaskan Coastal Studies
- Unocal
- Alaska Oil and Gas Association
- Kenai River Sport Fishing Association
- Stakeholder Representative Tourism Industry
- Stakeholder Representative, Commercial Fishing
- Kenai River Property Owners Association
- Alaska Support Industry Alliance

Native Organizations and Corporations

- Chugach Alaska Corporation
- Cook Inlet Region, Inc.
- Cook Inlet Tribal Council
- Tyonek Native Corporation
- Seldovia Native Association
- English Bay Corporation
- English Bay Village Council
- Port Graham Corporation
- Port Graham Village Council
- Kenai Native Association
- Ninilchik Native Association
- Salamatof native Association

Environmental Organizations

- Alaska Marine Conservation Council
- Kachemak Heritage Land Trust
- The Nature Conservancy
- Cook Inlet Keeper
- Cook Inlet Regional Citizen's Advisory Council
- Kenai River Watershed Forum
- Trustees for Alaska
- Wilderness Society
- Sierra Club

EVOS Principal Investigators.

- APEX
- SEA
- Investigation of Data System for EVOS Long Term Monitoring
- Ecological Characterization of Kachemak Bay
- PWS Human Use Model
- Synthesis of Scientific Findings

Cook Inlet Coalition:
Gregg Kellogg, EPA
Gary Saupe, DEC
Jerry Hupp, USGS
Phil North, EPA
Barbara Molyneaux, UAA, AK Cooperative Extension Service
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Paul Jackson, Chugachmiut
Sanne Berrig, Cook Inlet Resources Commission
Susan Saupe, Cook Inlet Regional Citizen's Advisory Council
Elaine Major, UAA
Carl Pulliam
Curtis Smith, ADF&G
Kurt Eilo, EPA
Dennis Tol, BLM
Paul Jackson, Nature Conservancy

COOK INLET AREA WIDE LEASE SALE STAKEHOLDER REPRESENTATIVES
Ken Castner, Homer, commercial Fishing
Jim Golden, Soldotna, Sportfishing Associations
Al Hastings, Anchorage, CIRI, Native Corporation
Stefanie Gorder, Kenai, Tourism Industry
Charles Quarre, Sterling, Private Landowner, Kenai River Property Owners Assoc. and Kenai River Watershed Forum
Peter Van Tuyn, Anchorage, Trustees for Alaska, Environmental Groups
Kevin Tabler, Anchorage, Unocal, Alaska Oil and Gas Association
Sandy Otto, Palmer, Private Land Owner
Joette Storm, Anchorage, Private Land Owner
Emil McCord, Jr., Tyonek/Anchorage, Native Tribal Councils
Bill Stamps, Kenai, Alaska Support Industry Alliance

APPENDIX D
Sample Outline for User Needs Analysis Workshop

Review Current Situation

1. Lack of standardized database management approach to organizing data
2. Diverse data organization across subject areas
3. Logical connections between databases in different subject areas is minimal
4. Diverse platforms (logically and geographically) holding data

Set Goals for the Information Management Effort

1. Improve access to the data
2. Improve availability of the data
3. Improve program integration

Follow a Systems Approach

1. Set goals
2. Set Criteria and Measures of Merit
3. Discuss Options
4. Perform Evaluation of Options
5. Make Decisions
6. Iteration of Decisions
7. Reach Consensus
8. Implement the System

Follow These General Information Management Guidelines

1. Build data systems across geographic and jurisdictional boundaries
2. Take advantage of new technology
3. Avoid investment in technologies that have to be replaced quickly
4. Recognize different level of ability of users
5. Ease of implementation – anything that takes too long is obsolete
6. Cost – anything which takes too much money is impossible
7. Human factors – positive cost/benefit for all participants
8. Provide tools to participants to promote common standards
9. Persuasion rather than compulsion

Propose Database Design Goals

1. To conform to FGDC metadata standards
2. To integrate the design of independent subject databases (i.e., monitoring, modeling, living resources, toxics, etc.)
3. To geographically locate the databases for optimal access by Cook Inlet watershed users
4. To design data tables logically for efficient data retrieval and downloading
5. To rank and profile database design models for the Cook Inlet Watershed Subject areas
6. To list mandatory data table design attributes and requirements for all Cook Inlet Watershed databases
7. To list design attributes and requirements for major Cook Inlet program subject areas
8. To list evaluation criteria for data table design, i.e., how does the data table meet user needs

Propose High Level System Function Goals

1. To know what data are available and to know enough about the data to use it appropriately
2. Analyze data spatially
3. Provide simple descriptive statistics about the data
4. To access raw and processed data
5. To access output from models
6. To facilitate statistical analysis of the data

Develop Evaluation Criteria

1. Perform required user functions
2. Build on and improve the existing framework
3. Employ technologies that are technically sound and reasonable, cost effective and can be implemented in a reasonable time frame
4. Incorporate flexibility to meet individual program areas needs without sacrificing integration
5. Address a wide range of data types and data users/providers

Potential Workshop Recommendations

1. Adherence to data standards
2. Suggest subject areas for prototyping (permitting, leasing,.....)
3. Database design models, i.e., relational, flat files, ...
4. Database systems and locations – central vs. distributed

Appendix E
A Subset of Data pertaining to Cook Inlet Information Management from:

INFORMATION MANAGEMENT FOR USE IN WATERSHED PLANNING FOR ALASKA

By
Keith Boggs, Colleen Libbey and Julie Michaelson

ALASKA NATURAL HERITAGE PROGRAM
University of Alaska Anchorage
707 A Street, Anchorage, Alaska 99501

For U.S. ENVIRONMENTAL PROTECTION AGENCY
Alaska Operations Office
222 W 7th Ave.
Anchorage, Alaska

October 1997

Dataset ID	Description
Air Quality	
Air Quality Subsystem U.S. Environmental Protection Agency	"Air Quality Subsystem (AQS) is a subsystem of the EPA's huge Aerometric Information Retrieval System (AIRS) which is a computer based repository for airborne pollution data in the U.S. and other countries. AQS contains air monitoring data and associated meteorological data collected by monitoring stations operated by EPA, local, state, and federal agencies. AQS contains data on the following, but is not limited to the items listed: ambient air quality, air facilities, emissions inventory, criteria pollutants, and some air toxics. These data are used by the EPA to identify areas that are in need of air quality improvements, and it is used to access the status of the nation's air quality in order to comply with the Clean Air Act. "
AIRS Facility Subsystem U.S. Environmental Protection Agency	"This data subsystem contains emissions, compliance data. and permit data for stationary sources that are regulated by the EPA, state, and local air pollution agencies. States use this information in preparation of State Implementation plans, in order to track the compliance status of point sources with various regulatory programs, and to report emissions estimates for pollutants regulated under the Clean Air Act. "
AIRS Graphics (AG) U.S. Environmental Protection Agency	"AIRS Graphics is a subsystem of the EPA's airborne pollution system, AIRS. AG presents data from AIRS in the form of maps and charts. These maps and charts bring to light patterns, trends, and anomalies in air pollution data that might be difficult to notice from tabular data. AG is used to integrate data from multiple AIRS subsystems, and displaying that data graphically to show spatial and temporal relationships."
Environmental Data Management System Alaska Department of Environmental Conservation; U.S. Environmental Protection Agency	"This dataset contains air quality data on the following: 1) simulant airs, 2) site information, 3) actual monitoring data for different types of pollutants, 4) non-criteria and criteria pollutants, and 5) some meteorological data. "
"Geographic, Common, and Maintenance Subsystem" U.S. Environmental Protection Agency	"This data subsystem is a repository of reference data and control information shared by two other subsystems of the EPA's airborne pollution data system, AIRS. The data consists of codes and code description used to identify places, pollutants, processes, geographic information, and values for things such as air quality standards and emission factors. "
Technology Transfer Network U.S. Environmental Protection Agency	"The TTN is a dataset within the EPA' s airborne pollution system, AIRS. TTN is a collection of electronic bulletin board systems containing information about a variety of areas of air pollution science, regulation, measurement, technology, and prevention. This serves as a type of public forum for the exchange of technical information and ideas. The TTN is available through the World Wide Web and through a traditional dial-up electronic bulletin board system. "
Aquatic Resources	
Anadromous Streams "Habitat and Restoration Division, Alaska Department of Fish and Game"	Data depict upper and lower extent of Anadromous fish streams throughout Alaska and are updated regularly.
Automated Data Processing (ADAPS) "Water Resources Division, U.S. Geological Survey"	"Surface water discharge information is kept in this database. Surface water data such as: lake levels, dam information, dam releases, and contract data are just a few of the things available from ADAPS. USGS has 85 full-time stream gaging stations, and 60 part-time stations in the state. The stream flow data can be used at the local, state, and federal level for flood forecasting, recreation, or low-flow water availability and other things. Historical stream flow data are available for 2600 sites, and current Alaska conditions are available via satellite. "

Dataset ID	Description
Bathymetry-Exxon Valdez Oil Spill Database National Ocean Services; Alaska Department of Natural Resources	"Raw bathymetric data was received from National Ocean Services (NOS). The data are in a fifteen second grid format with an average sea depth recorded for each cell. Areas of missing or scattered data were covered by manual entry of over 12,000 points from published NOS charts (scale 1:80,000). This dataset was compiled to provide bathymetry information for the oil spill damage assessment and restoration efforts."
Clam Study Sites- Exxon Valdez Oil Spill Alaska Department of Natural Resources: Alaska Department of Fish and Game	"The Database consists of ADF&G clam study sites in the spill affected area. The intended purpose of this database is to provide a resource for use in the oil spill damage identification, oil spill response, habitat restoration activities."
Coded Wire Tag Database-Salmon "Commercial Fisheries Management and Development Division. Alaska Department of Fish and Game"	This database is used to evaluate hatchery practices and estimate hatchery contributions. It is used for in-season fisheries management and a variety of research and restoration activities. Fish are tracked from release to return.
Fish Hatchery Sites Alaska Department of Fish and Game	Map of fish hatchery site locations.
Fisheries Information Management System (FIMS) "LGL, Alaska Research Associates"	"Fisheries Information Management System (FIMS) is a prototype computer system that links datasets routinely used by fisheries managers. This system is a relational data base structure. Output products include tables, statistical presentation and graphics. datasets included in FIMS are NMFS weekly processor reports, NMFS survey data, NMFS observer data, NMFS FOCI data (oceanographic/climate), ADF&G CFEC fish ticket data, IPHC catch data, IPHC tagging studies, NMML sea lion data, regulatory data, sea surface temperature, bathymetry data, coastline data. "
"Hydrography - 1:63,360 (ITM1)" "Land Records Information Section, Division of Support, Department of Natural Resources (DNR)"	"The Basemap Project captures hydrographic information by USGS quadrangles at 1:63,360 scale for the Alaska Department of Natural Resources. This information is used as base data for the state's graphic land records, known as status plats."
Hydrologic Unit Coes (HUC) for the State of Alaska "Bob Lamke, U.S. Geological Survey"	"Hydrologic Unit Codes (HUC) for the State of Alaska are shown. An HUC shows the boundaries of river basins and numeric codes for each basin. Bob Lamke revised HUC boundaries on 1;250,000 quads for the State of Alaska. Revised boundaries were digitized, edited and quads joined to complete HUC coverage for the State. "
Lakes Greater than 20 Acres "Land Records Information Section, Division of Support, Department of Natural Resources (DNR)"	"Statewide lakes greater than 20 acres was assembled from seventeen separate files in the USGS 1:2,000,000 Digital Line Graphs (DLG). "

Dataset ID	Description
Major Rivers "Land Records Information Section, Division of Support, Department of Natural Resources "	"Selected major rivers were extracted from all rivers and streams in the USGS 1:2.000,000 Digital Line Graphs (DLG) dataset. The major rivers include the Copper, Susitna, Kuskokwim, Yukon, Koyukuk, Kobuk, Noatak, and Colville Rivers. There are over 5300 arcs in this coverage with at least 25 arc attributes. "
Microresults on Shellfish Waters "Sewer Safety Laboratory, Division of Environmental Health, Alaska Department of Environmental Conservation "	"The laboratory results from shellfish areas throughout the state are contained here, along with a schedule for the next inspection date of an area. "
Paralytic Shellfish Poisoning Results "Sewer Safety Laboratory, Division of Environmental Health, Alaska Department of Environmental Conservation "	Paralytic Shellfish Poisoning Results are contained in this dataset.
Release Records Alaska Fish and Game Department	The Fish and Game Department uses this database to record all releases of all hatchery fish by stock and species.
Rivers "Land Records Information Section, Division of Support, Department of Natural Resources "	"Statewide rivers and streams were assembled from eighteen files in the USGS 1:2.000,000 Digital Line Graphs (DLG) dataset. "
Shellfish Waters Alaska Department of Environmental Conservation	"Certified shellfish (clams, oyster, and mussels) areas are listed. Information on marine toxins, water quality, and microbiology is also available; shellfish sampling stations and approval for wild harvest and/or marine culture are listed. "
Stocking Records- State Fish Hatcheries "Fisheries Rehabilitation Enhancement and Development (FRED), Alaska Department of Fish and Game"	This historical database records the numbers of fish stocked in any location around the state supplementing the sport and commercial fisheries. Data covers 1966 to the present although the older data tends to be less reliable.

Economics

1995 National Assessment of U.S. Oil and Gas Resources "National Oil and Gas Resource Assessment Team, U.S. Geological Survey"	This report summarizes results from a 3-year study of the gas and oil resources of State waters and onshore areas in the U.S. by the U.S. Geological Survey. Various maps are provided that show such things as petroleum regions and assessment areas. Total technically recoverable oil and gas resources based on onshore and in State waters is provided. The purpose of the National Oil and Gas Resource Assessment Project is to develop scientifically based hypotheses concerning the quantities of oil and gas that could be added to the proven (measured) reserved in the United States.

Dataset ID	Description
1995 Annual Report on Alaska's Mineral Resources "U.S. Geological Survey, Minerals Management Service, National Park Service, U.S. Bureau of Mines, U.S. Fish and	"This report is compiled annually as a result of the Alaska National Interest Lands Conservation Act of 1980 which requires all pertinent public information relating to minerals in Alaska be gathered by USGS and any other federal agency. Information is provided for two broad categories of minerals: nonfuel-mineral resources and energy resources. The following information is also provided: 1) a description of all federal mineral programs, 2) various information on energy resources such as exploration, production, and leasing of oil and gas resources; coal and peat resources, and activity by federal agencies, and 3) non-fuel resources information such as Economic overview, precious metals, mining districts, and other information. "
"Alaska's Mineral Industry 1995, Special Report 50" "Alaska Division of Geological and Geophysical Surveys, Alaska Division of Trade and Development, Alaska Division	"The report is intended to provide accurate information about Alaska's mineral industry activities during each calendar year. A summary of exploration in Alaska is provided, along with more detailed sections focusing on exploration, development, production, drilling, recycling, government action, and reclamation. "
Alaska Mineral Locations Database "Division of Lands Minerals and Resources, U.S. Bureau of Land Management"	"This mineral occurrence and mineral deposit database has basic location information, present commodities, and some bibliographic references. "
Community Profile Database "Division of Subsistence, Alaska Department of Fish and Game"	"The database was designed to serve as a principal reference source for recent, reliable, summary information about the subsistence uses within economies of rural Alaska. A Geographical and Sociopolitical Summary is provided and contains such variables as community name, location, house election district, road connected status, rural or non-rural status, federal subsistence region, ecological-cultural zone, game management unit, and wildlife conservation division management region. An Issues Summary deals with areas of concern pertaining to the communities use of wild resources. In addition to the above summaries, there are also Economic, Demographic, and Harvest and Resource Use summaries. "
Cplan Alaska Department of Environmental Conservation	"Large oil facilities, 420,000 gallons or larger, are recorded in this database. The facility name, size, storage capacity, and owner address are some of the fields used. "
Land Administration System "Oil and Gas Lease Division, Alaska Department of Natural Resources"	"Oil and gas lease information with regard to who has the lease, what type of lease it is, and the issue date and expiration of the lease, is given . The land status (property boundaries) of a lease can also be found in this dataset along with other pertinent lease information."
Mariculture Permit Tracking "Fisheries Rehabilitation Enhancement and Development (FRED), Alaska Department of Fish and Game"	"The database tracks the status of mariculture permit applications in the department's permitting process, maintaining information on all mariculture ventures in the state. "
Mineral Terranes and Known Mineral Deposit Areas Resource Data Inc.	The purpose of this publication is to show areas of Alaska with potential for the discovery of resources of metallic minerals.

Dataset ID	Description
National Inventory of Dams U.S. Army Corps of Engineers; Federal Emergency Management Agency (FEMA)	"This is a profile of 75,000 dams at the State or Federal level. Each dam has a file of 35 different fields, including but not limited to the following: dam name, location, history, purpose, inspection dates, storage capacities, hazard potential, and many others. These data allow FEMA to assess overal safety hazards proposed by U.S. dams, and these data are used to analyze needs and target resources for navigation. flood control, hydroelectric power, wildlife protection, watershed management, recreation projects, and water supply. "
Oil and Gas Wells Listed Oil and Gas Conservation Commission	"Data included are: well name, field, pool, permit number, date issued, date approved, geological area, surface/bottom hole information, well depth, operators' names/numbers, oil/gas production by field pool, and other information for all oil and gas wells listed in the State."
Oil/Gas/Mineral Activities Database "Division of Refuges, U.S. Fish and Wildlife Service"	"This module of the Refuge Management Information System (RMIS) contains information dealing with the presence or absence of a variety of oil, gas, and mineral activities by refuge. "
Records Management "Oil and Gas Lease Division, Alaska Department of Natural Resources"	"This is an archive dataset that contains the who, what, when, where, and other pertinent lease information from past leases. "
Subsistence Land Use Maps "Subsistence Division, Alaska Department of Fish and Game"	Blueline maps showing subsistence harvest areas for Alaskan communities. Most were prepared as resource maps for Alaska Management Guides.
Well Status Information Alaska Department of Natural Resources	This dataset consists of tables that show status and other public data for all exploration oil and gas wells since 1994 in Alaska and nearby Outer Continental Shelf regions. Most development and service wells are excluded.

Ecosystem and Watershed Scale

A Phase 1 Inventory of Current EPA Efforts to Protect Ecosystems "Office of Water, U.S. Environmental Protection Agency"	"This document includes summaries of projects dealing with place-based management and ecosystem protection involving the EPA and its partners. This inventory is divided into three major parts: 1) large-scale ecosystem protection efforts, 2) regional summaries of local scale ecosystem protection efforts, and 3) multisite ecosystem protection efforts. The purpose of this document is to let readers in the EPA and outside the EPA know of the increasing amount of ecologically oriented activities the EPA is participating in. "
Alaska Aquatic Resources Information Management System (AARIMS) U.S. Bureau of Land Management	"AARIMS is used to manage inventory and monitoring information for aquatic resources, including habitat, fish populations, water quality, etc. "
Alaska Biological Conservation Database "The Nature Conservancy; Alaska Natural Heritage Program, University of Alaska Anchorage"	"The BCD contains information on Threatened, Endangered, and Sensitive (TES) plants and animals in Alaska. A variety of data are available such as: 1) lists of TES plants and animals within a geographic area, 2) biological information such as habitat and range, and 3) status rankings for Federal, State, and the Nature Conservancy TES species in Alaska. Aquatic and Wetland species at risk information is an important part of assessing biological diversity in a waterbody and determining the health of a watershed. "

Dataset ID	Description
Alaska Climate Summaries "Arctic Environmental Information Data Center, University of Alaska Anchorage"	"This is an archive of daily climate observations taken at 478 Alaska Cooperating Climate Stations, updated through 1987. One page long-term summaries of monthly means and extremes were compiled for each reporting station. "
"Alaska Coastline - 1:250,000" "Oil and Gas Division, Alaska Department of Natural Resources; North Slope Borough; National Oceanic and	This is the most detailed digital coastline coverage which is currently available for the entire state.
Anchorage Daily News Weather Anchorage Daily News	The Climate Center archives the weather page from the Anchorage Daily News which gives general weather conditions throughout the state.
Bathymetric Maps "Coast and Geodetic Survey, National Ocean Service, National Oceanic and Atmospheric Administration"	"Topographic maps of the sea floor. Through the use of detailed depth contours and full use of bathymetric data, the size, shape and distribution of underwater features are vividly portrayed. Scale for all Prince William Sound maps is 1:250,000. The regional map for the Gulf of Alaska (an incomplete blueprint) includes Glacier Bay and is at a scale of 1:1,000,000."
Canadian Coastline CIA World Bank II	"This coastline was originally received from the U.S. Fish & Wildlife Service. It contains only the Canadian boundaries close to Alaska. The CIA World Data Bank compiled data files about coastlines, countries, rivers, islands, and lakes of the world. "
Climate Data "National Weather Service, National Climatic Data Center, National Oceanic and Atmospheric Administration"	"Daily, normal, and extreme weather conditions are given as recently as the day before the present day. "
Climatological Data National Climatic Data Center; National Environmental Satellite Data and Information Service; National Oceanic and	"This dataset provides weather data for the entire state of Alaska. Data are available on a monthly and daily basis in the following areas: temperature, precipitation, snowfall, and other areas. There is also a station index, listing all weather stations, the county they are in, and their latitude and longitude. A map of Alaska is provided."
Digital Chart of the World (DCW) Environmental Systems Research Institute (ESRI)	"The DCW is a vector basemap of the world at a scale of 1:1,000,000. The database consists of geographic, attribute, and textual data. There is an Alaska module available, that consists of all available layers covering only the State of Alaska. Themes include: oceans, populated places, railroad, utilities, drainage, supplemental drainage, hypsography, and hypsography supplemental."
DOTPF Wind Data Alaska State Climate Center	This dataset consists of wind data for selected airport sights used for runway realignment.

Dataset ID	Description
Earthquake 1964- Exxon Valdez Oil Spill Database "Land Records Information Section, Division of Support, Alaska Department of Natural Resources"	"The dataset depicts the contours of geomorphic displacement measured in feet from the 1964 Earthquake at a 1:2,000,000 scale. Displacement ranges from approximately -8 feet to 35 feet near Montague Island. This data layer was intended as a resource for use in the damage assessment and restoration efforts of the Exxon Valdez Oil Spill geoprocessing group."
Ecoregions of Alaska "Gallant, A.L.; U.S. Geological Survey Eros Alaska Field Office; U.S. Environmental Protection Agency"	"Ecoregions are based on perceived patterns of a combination of causal and integrative factors including land use, land surface form, potential natural vegetation, and soils. This map consists of 20 ecological regions that were derived by synthesizing information on the geographic distribution of environmental factors such as terrain, climate, vegetation, and others. A map of ecoregions of Alaska has been produced as a framework for organizing and interpreting environmental data for state, national, and international inventory, monitoring, and research efforts. "
Exploratory Soil Survey for Alaska U.S. Natural Resource Conservation Service formerly Soil Conservation Service	"This theme contains information useful in large-scale planning. Of primary importance are the predictions of soil behavior for selected land uses. Also highlighted are inherent limitations or hazards of the soils for land uses and the impact that selected land uses will have on the environment. Suitability ratings are given for uses such as: common crops, rangeland for cattle and sheep and reindeer, commercial forestry, road locations, low buildings, recreation and off-road trafficability."
Geographic Information System Database Summary "Division of Support Services and Land Records Information, Department of Natural Resources"	"This summary contains a broad range of categories dealing with Alaska; major areas are: physical features, cultural features, graticules, templates, townships, survey control monuments, protracted section grids, hydrography, land status, and cartographic tools. The purpose of this summary is to assist someone in choosing the appropriate dataset. "
Glaciers "Land Records Information Section, Division of Support, Department of Natural Resources (DNR)"	This is a digitized map of statewide glaciers.
Global Surface Summary of Day Data National Climatic Data Center; National Environmental Satellite Data and Information Service; National Oceanic and	"Global surface summaries are included for more than 8,000 stations. These include the latest month's data, consisting of mean temperature, mean dew point, mean sea level pressure, mean station pressure, mean visibility, mean wind speed, maximum sustained wind speed, maximum wind gust, maximum temperature, minimum temperature, precipitation amount, and snow depth. There is also an indicator occurrence of: fog, rain, snow, hail, thunder, tornados, and funnel clouds. "
Hypsography "Land Records Information Section, Division of Support, Department of Natural Resources "	"The Alaska Department of Natural Resources (ADNR) has combined hypsography for several Digital Chart of the World (DCW) titles into one coverage. Some edits to the data were made, which allowed ADNR to label high elevation points and mountain tops from the DCW data. The coverage contains elevation contours at every 1,000 feet. The hypsography used for statewide maps is often depicted as a contour line at every 3,000 feet, which offers visualization of vertical control as it relates to other map features. "
Issue Database U.S. Fish and Wildlife Service	"Federal proposals for subsistence use on federal lands are contained here. No information is available for state, private, or native lands, only federal. Minimal summary information and an index of files are provided."

Dataset ID	Description
Latitude and Longitude Lines Every 2 Degrees "Land Records Information Section, Division of Support, Department of Natural Resources "	This file contains latitude and longitude lines for every two degrees spanning the state.
Latitude and Longitude Lines Every Degree "Land Records Information Section, Division of Support, Department of Natural Resources (DNR)"	This file contains latitude and longitude lines for every degree spanning the state.
Local Climatological Data National Climatic Data Center; National Environmental Satellite Data and Information Service; National Oceanic and	"This dataset includes data for most weather stations in Alaska. Weather information with regard to temperature, precipitation, pressure, sunshine, cloudiness, visibility, and wind, is available on a 3-hourly interval basis. "
Locational Reference Tables (LRT) U.S. Environmental Protection Agency	"LRT act as a repository for locational information that has been collected by the EPA as a result of EPA's Locational Data Improvement Projects. The primary objective of this project is to identify, collect, verify, store, and maintain an accurate, consistently documented set of locational data for entities of environmental concern. The LRT contains documented latitude and longitude values for EPA-regulated facilities. "
Major Ecosystems of Alaska Map U.S. Geological Survey	"This is a polygon coverage of the Major Ecosystems of Alaska map unit boundaries. The boundaries were delineated by the Joint Federal-State Land Use Planning Commission for Alaska in 1973 at 1:2,500,000-scale. This data will primarily be used to display the location of Major Ecosystems throughout Alaska. "
Monthly Precipitation Data for U.S. Cooperative and National Weather Service Sites National Climatic Data Center; National Environmental Satellite Data and Information Service; National Oceanic and	"This dataset contains historical monthly precipitation data for all U.S. cooperative and National Weather Service Stations. There are more than 8,000 weather stations that are still active included in this dataset, and many inactive weather stations are also included. These data contain the latitude/longitude for each station. "
National Biological Information Infrastructure (NBII) "Biological Resources Division, U.S. Geological Survey"	"The NBII provides information on and access to information products, biological databases, directories, and guides maintained at the private, local, State, and Federal level. "
National Resources Inventory (NRI)- Wetland Loss Index Natural Resources Conservation	"The National Resources Inventory is a comprehensive database on natural resources throughout the United States. The database focuses on soil, water, and related resources. The Wetland Loss Index is a watershed condition data layer dealing with recent wetland loss rates combined with historic loss rates. This index is an excellent indicator of watershed condition. "

Dataset ID	Description
NOAA Nautical Charts "Coast and Geodetic Survey, National Ocean Service, National Oceanic and Atmospheric Administration"	"Conventional flat nautical charts for navigation are assigned to different scale groups. Harbor Charts are 1:50,000 or larger and are intended navigation and anchorage. Coast Charts are 1:50,000 to 1:150,000 and are intended for coastwise navigation inside the offshore reefs and shoals, entering bay and harbors of considerable size, and navigating certain inland waterways. General Charts are 1:150,000 to 1:600,000 and are intended for use when a vessel's course is well offshore, but when its position can be fixed by landmarks, lights, buoys, and characteristic soundings. Nautical charts are in the process of being put into a raster format but are not yet available. "
Permafrost U.S. Geological Survey EROS Alaska Field Office	"This dataset is comprised of a georeferenced digital map and attribute data derived from the publication "Permafrost Map of Alaska". The map is presented at a scale of 1:2,500,000 and shows the correlation of physiographic province to presence of permafrost across the State of Alaska. "
Physiographic Divisions of Alaska "U.S. Geological Survey, EROS Alaska Field Office"	"This dataset is comprised of a georeferenced digital map and attribute data derived from the publication ""Physiographic Divisions of Alaska"". The map is presented at a scale of 1:2,500,000 and shows the generalized land form divisions. "
Protracted Section Grids (QMQ1) "Land Records Information Section, Division of Support, Alaska Department of Natural Resources (DNR); Bureau of	"Section boundaries were generated using BLM, DNR, and U.S. Fish and Wildlife computer programs and township coordinate files for the construction of digital protracted sections. Scale is 1:250,000."
"Quadrangle Boundaries 1:250,000" "Land Records Information Section, Division of Support, Department of Natural Resources (DNR)"	"This coverage contains the boundaries of the USGS protracted 1:250,000 quadrangle maps covering Alaska. It also includes annotation for the quadrangle names in the annotation subclass qmqanno. "
Quadrangle Boundaries 1:63.360 "Land Records Information Section, Division of Support, Department of Natural Resources (DNR)"	"This coverage contains the boundaries of the USGS protracted 1:63,360 quadrangle maps covering Alaska. "
Record of River and Climatological Data "National Weather Service, National Oceanic and Atmospheric Administration"	"Second Order weather stations in Alaska which do not have computer or satellite data record daily weather observations in this dataset. All observations are entered manually for the following categories: temperature, precipitation, type of weather, and river stage. "
RPA Database U.S. Forest Service	"This national database covers all forest land across all ownerships in the United States. Forest summaries include classification, volume, and species data, which provide measures of the forest that allow an assessment of forest land use trends, productivity, biodiversity, ecosystem distribution, condition, and structure. The purpose of this database is to provide trend information on the extent, condition, ownership, and composition of U.S. forests. It also provides information on wildlife habitat, forage information, and other resource characteristics needed for resource management and planning. "

Dataset ID	Description
State Coastline-Exxon Valdez Oil Spill Database "Land Records Information Section, Division of Support, Alaska Department of Natural Resources; Chugach National	"The dataset consists of digitized shoreline data (i.e., salt water/land interface) for three geographic areas of Prince William Sound (PWS), Cook Inlet/Kenai Peninsula (CIK) and Kodiak/Alaska Peninsula (KAP). The shoreline data used to cover the Exxon Valdez Oil Spill region is currently shared and held in common by the involved State and Federal agencies. This transaction occurred early on after the spill so subsequent data related to the coastline would be consistently defined. "
Surf Your Watershed U.S. Environmental Protection Agency	"Surf Your Watershed is the EPA's web site that provides a service to help you locate, use, request information, and share environmental information on your watershed or community. You can find out recent environmental protection efforts, environmental quality indicators, socio-Economic factors, and so much more at this web site. Localized detailed data from State, Tribe, local, and other sources that would be pertinent for watershed management are available. "
Synthetic Aperture Radar (SAR) "Synthetic Aperture Radar (ASF), University of Alaska Fairbanks"	"The dataset consists of European Remote Sensing Satellite #1 (ERS)-1 and Japanese Earth Resource Satellite (JERS)-1 SAR data acquired by the ASF operated by the Geophysical Institute of University of Alaska Fairbanks. Data within the station mask of ASF, approximated by a 3000 km radius circle 1992 for JERS. "
The National Climatic Data Center's On-Line Access and Service Information System (OASIS) National Climatic Data Center; National Environmental Satellite Data and Information Service; National Oceanic and	"Various weather data inventories are available via the internet. Hourly weather such as surface observations and precipitation are included. In addition there is access to data dictionaries, station histories, field experiment information, and data inventories. These data are available through the internet, but instructions from the NCDC are necessary to access the data. "
Universal Transverse Mercator Grid "Land Records Information Section, Division of Support, Department of Natural Resources "	"This dataset contains the longitude lines which define the Universal Transverse Mercator (UTM) Grid, zones 1-9, plus 59 and 60. Coordinates in the UTM projection are given in meters with numbers increasing toward the east and north, zones 1 through 10. The system of rectangular plane coordinates is established by the National Geodetic Survey, National Ocean Service."
"USGS Digital Elevation Models 1:63,360" "Earth Sciences Information Center, U.S. Geological Survey (USGS-ESIC)"	"Digital Elevation Model (DEM) data consist of an array of regularly spaced elevations. DEM data in 15-minute units consist of regular arrays of elevations arranged horizontally to the coordinate system of NAD 27. The spacing between elevation along profiles is 2 arc seconds of latitude by 3 arc seconds of longitude. Each profile has 451 elevations. DEM data for 15-minute units correspond to the USGS 15-minute topographic quadrangle map series in Alaska. The unit sizes in Alaska vary depending on the latitude. Unit south of 59 degrees North cover 15x20-minute areas, those between 59 and 62 degrees North cover 15x22.5-minute areas."
USGS Digital Line Graphs "Earth Sciences Information Center, U.S. Geological Survey (USGS-ESIC)"	"Digital Line Graph (DLG) data are digital representations of cartographic information. DLG's of topographic and planimetric map features are derived from cartographic source materials using manual and automated digitizing methods. The USGS DLG data are classified as large (1:63,360) intermediate (1:1,000,000), and small (1:2,000,000) scale. Large-scale DLG data are available in nine categories: 1) hypsography, 2) hydrography, 3) vegetative surface cover, 4) non-vegetative features, 5) boundaries, 6) survey control markers, 7) transportation systems, 8) manmade features, and 9) US Public Land Survey System, including township, range, and section information. Intermediate-scale DLG's are sold in five categories: 1) Public Land survey, 2) boundaries, 3) transportation, 4)

Dataset ID	Description
"USGS Topographic 1:25,000 Maps" "Earth Sciences Information Center, U.S. Geological Survey (USGS-ESIC)"	"Topographic quadrangle maps at 1:25.000 scale. Terrain is portrayed by contour lines and features such as roads, towns, water areas, and vegetation are shown by map symbols and colors. Contours are in 5, 10, or 20 meter intervals. Maps were produced from aerial photos taken between 1972-1986. "
"USGS Topographic 1:250,000 Maps" "Earth Sciences Information Center, U.S. Geological Survey (USGS-ESIC)"	"Topographic quadrangle maps at 1:250.000 scale. Terrain is portrayed by contour lines and features such as roads, towns, water areas, and vegetation are shown by map symbols and colors. Contours are at 200 foot intervals."
Weather from the Alaska Climate Research Center National Climatic Data Center; National Environmental Satellite Data and Information Service; National Oceanic and	General weather information for Alaska's First Order Stations is available via the internet.
Western Regional State Climate Summaries "Western Regional Climate Center, National Oceanic and Atmospheric Administration "	"Provides weather information on temperature, precipitation, snowfall, snow depth, and other areas. "

Planning and Cultural Resources

1996 Alaska Village Sanitation Improvement Projects "Technical & Data Management Section, Division of Land, Alaska Department of Natural Resources"	This map shows the location and project phase of the Alaska Department of Environmental Conservation's Village Sanitation Projects.
1996 Alaska Village Sanitation Status "Technical & Data Management Section, Division of Land. Alaska Department of Natural Resources"	This map shows the percent of homes in each village with pipes or enclosed haul. Projections are also made for the year 2000.
A Commitment to Alaskans Executive Summary "Alaska Sanitation Task Force, Alaska Department of Environmental Conservation"	"This document contains recommendations developed by the Alaska Sanitation Task Force to offer a long term strategy for improving sanitation conditions in rural Alaska. The document addresses such issues as: 1) housing sanitation standards, 2) planning, construction, and design for the sanitation facilities, 3) utility management, 4) research and development, and many other areas. "
Alaska Airports Resource Data Inc.	This data layer contains centroid of all public and private runways in Alaska from FAA tabular data.

Dataset ID	Description
"Alaska Cities, Towns, and Villages" Resource Data Inc.	"Statewide ARC/INFO coverage with attribute text on cities, towns and villages generated from Federal Aviation Administration (FAA) tabular files. "
Alaska Coastal Zone Boundaries "Alaska Coastal Zone Management Program, Division of Governmental Coordination, State of Alaska contract to	"The database is a Statewide depiction of Alaska's Coastal Zone boundaries, and Alaska Department of Fish and Game's associated boundary narratives. updated in 1994. Data are limited to use at a 1:250,000 scale or smaller and are intended for use at a regional or statewide scale for general planning purposes."
Alaska Community Profiles-Maps Alaska Department of Community and Regional Affairs	Maps of nearly all rural villages in Alaska are in this database.
Alaska Coordinate System of 1927 "Land Records Information Section, Division of Support, Department of Natural Resources (DNR)"	"This dataset contains the longitude lines which define the Alaska Coordinate System of 1927, state plane zones 1 through 10. The system of rectangular plane coordinates is established by the National Geodetic Survey, National Ocean Service, for defining and stating the positions of points on the surface of the earth for the state of Alaska."
Alaska Heritage Resources Survey "Office of History and Archeology, Division of Park's and Outdoor Recreation, Department of Natural	"The Alaska Heritage Resource Survey (AHRS) is an inventory of all reported historic and prehistoric sites within the State of Alaska and is maintained by the office of History and Archeology. This inventory of cultural resources includes objects, structures, buildings, sites, districts, and travel ways with a general provision that they be over 50 years old. "
Alaska Municipal Officials Directory Alaska Municipal League; Alaska Department of Community and Regional Affairs	"The names and phone numbers of city and borough officials in the State of Alaska are listed, along with the type of government, assembly members, school board members, municipal employees, planning and zoning commission members, municipal powers, and utilities/facilities operated. "
Alaska Native Claims Settlement Act Corporation Boundaries "Land Records Information Section, Division of Support, Alaska Department of Natural Resources"	"The boundaries of the native regional corporations created by the Alaska Native Claims Settlement Act (ANCSA) were derived in march 1992. Boundaries denote broad administrative limits used in the implementation of ANCSA. Recommend use at 1:1,000,000 or smaller."
"Alaska Native Claims Settlement Act, Section 14, C3 Status" Alaska Department of Community and Regional Affairs (DCRA)	Approximately 220 communities in the State of Alaska received land through the Alaska Native Claims Settlement Act (ANCSA). Through ANCSA each native owned corporation must convey some land to a city or the State. This database deals with the status of conveying the land. (i.e. satisfied or not satisfied)

Dataset ID	Description
Alaska Place Names Resource Data Inc.	"Statewide data coverage containing USGS Alaska Place names to include cemetery sites, local, military sites. mines, populated places."
Alaska Population Overview "Research and Analysis Section, Alaska Department of Labor"	"Alaska Population Overview provides frequently requested population information in a single population, and it deals specifically with the resident population of Alaska. Population information on the State of Alaska as a whole, can be found in the following areas: population trends, Alaskan population history, migration, race composition, components of change, population as a whole, and several other areas. Population statistics are also provided for each borough and census area."
Alaska Regional Profiles Joint Federal-State Land Use Planning Commission; University of Alaska Anchorage	"The dataset is a series of six volumes covering Alaska that describe natural and manmade systems. A planning team made up of resource specialists prepared their respective resource summaries for each of six regions of the state. General themes include climate, topography, geology, hydrology, soils, biotic communities, cultural resources, land status and services. The intended use of this information was to provide resource information for federal, state, and local planning efforts particularly for land selections under ANILCA, and they reflect data current to early 1970's. Volumes I-Southcentral Region and IV-Southeast Region are applicable to BRD Ecosystem Initiative areas."
Alaska State Control Monuments "Land Records Information Section, Division of Support, Department of Natural Resources (DNR)"	Cadastral Survey Control plats show control stations established in areas of little control and where Supplemental Cadastral surveys were waived in order to meet requirements of specific programs initiated in 1979. A total of 943 monuments were captured in the data file from 168 Control Survey Plats. These primary control monuments are used to establish the locations of Alaska State Land Surveys (ASLS) and Supplemental Cadastral Control Surveys.
Alaskan Communities Flood Hazard Data "Flood Plain Management Services of the Alaska District, U.S. Army Corps of Engineers"	"Flood plains throughout the State are identified and flood plain histories are recorded. This information is intended to assist local, State, and Federal agencies with development in communities, and the Corps hopes to reduce the threat to life from flooding in Alaska and minimize flood-caused Economic loss. "
Borough Boundaries "Land Records Information Section, Division of Support, Department of Natural Resources "	Coverage includes all boroughs within the State of Alaska.
Cleared Areas Natural Resources Conservation	"Field Boundaries of non-urban areas are interpreted from aerial photography and digitized. Boundaries fall primarily along road systems. This dataset also identifies agricultural projects in use. The digitizing process is not yet complete. Data are available primarily for the following areas: Kenai, Fairbanks, Matanuska/Susitna, Delta Junction, Soldotna, and Kenny Lake"
Community Flood Data U.S. Army Corps of Engineers; Alaska Department of Community and Regional Affairs	"The Department of Community and Regional Affairs has taken U.S. Army Corps of Engineers information to compile a dataset of flood plain communities. The following are included: 1) high water elevation identification, 2) a historical record of high water elevation, 3) actions taken with regard to high water, 4) recommended building information, and 5) estimated flood damage. "
Compliance Assistance Database Alaska Department of Environmental Conservation	"The DEC uses this database to track their technical assistance activities. If someone was to call the DEC needing assistance the record of the call and how it was responded to, is maintained in this database. From these data the DEC can track whom they provide service to and what types of activity they are providing. "

Dataset ID	Description
Conservation System Unit Boundaries Land Records Information Section Division of Support Alaska Department of Natural Resources (DNR); Bureau of	"This dataset depicts the Federal conservation system units created by Alaska National Interest Lands Conservation Act, 1980. This data reflects original boundaries updated by various federal agencies involved."
Department of Community and Regional Affairs Community Profile Database Alaska Department of Community and Regional Affairs	"Information on each community and Borough in Alaska is provided in text form. The database contains information on the following things in those communities: government, population, location, history, culture. transportation, facilities, U.S. census, economy. employment, contacts, municipal offices, municipal finances, rural grants, schools, rural business licenses, and other areas. "
Election District Boundaries for 1994 "Land Records Information Section, Division of Support, Department of Natural Resources (DNR)"	This database depicts election district boundaries.
Flood Maps "Alaska Department of Community and Regional Affairs,"	"This dataset lists the National Flood Insurance Program (NFIP) communities that have maps available. It also lists the non-NFIP communities in the State. From this list you can obtain Flood Insurance Rate Maps (FIRM) which have a variety of information, such as: different types of flood zones, zone designations, 100 and 500 year flood boundaries, and base flood elevation in feet. "
Generalized Land Status "Land Records Information Section, Division of Support, Alaska Department of Natural Resources (DNR); Bureau of	"AKSTATUS is a Statewide summary of land ownership in Alaska. It includes the major categories of state, native, and federal holdings. Activity on state land is recorded, by section, in DNR's Land Administration System (LAS). "
Historical Transportation Routes "Land Records Information Section, Division of Support, Department of Natural Resources (DNR)"	This Statewide database depicts historical use trails that qualify as potential right-of-ways under the Federal Revised Statute 2477. These data reflect an extensive land ownership search of over 1200 historical trails evaluating each trail according to regulations of RS 2477. The intended use of this dataset is to provide a tool for the state's use to meet public access needs.
Indian Reservation Road Maintenance Survey U.S. Bureau of Indian Affairs	"Anything providing access to any recognized tribal village or reservation is considered a tribal road and is recorded in this database. If tribes have an airfield this is recorded and the field is categorized as state, private, tribal, or federal. "
Interim Lands Information System "Branch of Information Technology, Bureau of Land Management"	Federal Land Records for the State of Alaska in alpha format. Contains land records pertinent to federal lands under the jurisdiction of BLM.

Dataset ID	Description
Land Areas of the National Forest System U.S. Forest Service	"21 different tables which provide acreage figures on different types of USFS land are contained in this dataset. Types of land included are: National Wilderness Areas, National Primitive Areas, National Scenic Areas, National Wild and Scenic Rivers, National Recreation Areas, National Game Refuges and Wildlife Preserves, National Monuments, National Historic Areas, and National Forest Lands. "
Landview Resource Data Inc.	"Landview contains an inventory of all University of Alaska properties. It also contains a broad range of items for each property, such as acreage and legal descriptions. "
Municipal Land Trustee Program Alaska Department of Community and Regional Affairs	"The DCRA acts as a land trustee for unincorporated villages, those which are not cities. This dataset contains all the lands in their trust: it also contains what types of leases the DCRA has with villages, such as facilities, schools, centers, and other public facilities."
National Flood Plain Insurance Program Alaska Community Status List Alaska Department of Community and Regional Affairs	All communities (and pertinent information dealing with those communities) which participate in the National Flood Insurance Program (NFIP) are included in this database.
National Geodetic Survey Monuments "Land Records Information Section, Division of Support, Department of Natural Resources (DNR)"	"National Geodetic Survey Monuments show control stations established throughout the state by government as a source of primary horizontal survey control. A total of 22,277 monuments are captured in this coverage, with a NAD27 Datum. These primary control monuments are used to establish the location of federal, state, and private surveys. "
National Wildlife Refuge System Database of Secondary Uses "Division of Refuges, U.S. Fish and Wildlife Service"	"All refuges having secondary uses are documented in this database. Any secondary use being permitted to occur on a national wildlife refuge must be compatible with the purposes of the refuge. Each record in the database specifies, the use, whether USFWS can regulate it, how the refuge met the documentation requirement of the National Environmental Privacy Act, and other information. "
NWRS Descriptions and Identifiers System (FWSUnits.fm) "Division of Refuges, U.S. Fish and Wildlife Service"	"This database contains records for each organized unit of land administered by USFWS. Refuge name, Interior Fish and Wildlife Service number, organization code, state, acreage, and a brief general description of the unit are just some of the information included. "
Populated Places "Land Records Information Section, Division of Support, Department of Natural Resources "	Locations of Statewide towns and villages.
Protracted Offshore Sections (Base 5) "Land Records Information Section, Division of Support, Alaska Department of Natural Resources (DNR); Bureau of	Section boundaries were generated using BLM and DNR computer programs for the construction of digital aliquot parts. This coverage is intended to geographically represent DNR's protracted sections for offshore townships and is not capable of supporting survey quality area calculations.

Dataset ID	Description
Public Land Statistics 1996 (on-line) Bureau of Land Management	"The contents of these statistics deal with six primary categories: 1) Land Resources and Information, such as public lands under jurisdiction of the BLM and withdrawals and revocations; 2) Healthy Productive Lands, such as condition of riparian-wetland areas/types of wildlife habitat on public lands; 3) Commercial Uses and Revenues Generated, such as oil and gas activities; 4) Recreation and Leisure Activities, which includes things like estimated recreational use; 5) Preservation of Significant Cultural and Natural Features, which includes things such as land exchanges, and 6) Public Health, Safety, and Resource Protection; important information dealing with the release of hazardous substances on public lands is included in this category. There are a variety of other subcategories
Recording District Boundaries "Land Records Information Section, Division of Support, Department of Natural Resources "	"The Recording District Boundary coverage depicts the 34 recording districts established for the administration of the state's system for recording and filing of documents. The Portfolio dated September 1, 1964, was mandated by Alaska Supreme Court Order No. 12, Amendment No. 13, effective July 1, 1975. Recording district boundaries were originally depicted on 153 U.S. Geological Survey (USGS) quarter million quadrangle mylar maps, which are maintained by the Anchorage Recording District Office. The recording district boundaries are used to establish the locations in which any recorded public or private document must be recorded and filed. "
Refuge Purposes System (Ref_Purp.fm) "Division of Refuges, U.S. Fish and Wildlife Service"	"The establishment and acquisition purposes of each National Wildlife Refuge are included in this database. Data fields include refuge name, state, and refuge purpose. "
Refuge System Documents "Division of Refuges, U.S. Fish and Wildlife Service"	"All federal documents that are related to land acquisition of Refuge System lands are tracked in this database. Such things included are: federal register notices, wildlife orders, public land orders, executive orders, secretarial orders, and public laws. Fields include current name of station, previous name of station, document identifier, date of document, and effect of document. "
Regional Education Attendance Areas (REAA) "Land Records Information Section, Division of Support, Department of Natural Resources "	"The Regional Education Attendance Area (REAA) boundaries are important to state funding of School programs throughout Alaska. The boundaries were derived from source documents provided by the Alaska Department of Community and Regional Affairs, and boundaries extracted from state LAS Land file. "
Report to the Governor's Council on Rural Sanitation "Education and Training Subcommittee, Governor's Council on Rural Sanitation, Alaska Department of	"This report is just one of many that are submitted to the governor from the Council on Rural Sanitation. This report specifically deals with education and training efforts related to rural sanitation. There are six rural sanitation subcommittees, and each submits reports on a regular basis. The primary concerns of this council are public health, economic development, and quality of life for rural Alaska. "
Right of Way Alaska Department of Transportation and Public Facilities	All maps of existing Right of Way roads will be in this database when it is completed.
Roads "Land Records Information Section, Division of Support, Department of Natural Resources "	"Statewide roads were taken from the USGS 1:2,000,000 Digital Line Graphs (DLG) dataset. "

Dataset ID	Description
State Legislative Appropriation for Flood and Erosion Control SLA 1972-1991 Alaska Department of Community and Regional Affairs	"Each community that has received funding for flood or erosion control from 1972-1991 is included in this dataset. Fields include: 1) year funded, 2) agency who funded the control project, 3) a description of the project, 4) the legislative source, 5) grant amount, 6) project status, and 7) the community gra total. This is a good source to obtain a brief description and the location of flood and erosion control projects throughout the state. "
State Legislatively Designated Areas "Land Records Information Section, Division of Support, Department of Natural Resources "	"This dataset depicts location Statewide of state lands designated for special uses, including state forests, state parks, state wildlife areas, other multiple use areas, and restricted areas such as the Dalton Highway, Bristol Bay critical habitat area, and the Kachemak Bay area. "
Summary of Juneau Area Transportation U.S. Bureau of Indian Affairs	This contains tribal project listings and a list of possible future roads. The future roads are only suggestions arrived at from a survey of various tribes. Road route number and mileage are provided.
Township Boundaries "Land Records Information Section, Division of Support, Department of Natural Resources (DNR)"	Township boundaries were generated using Bureau of Land Management's (BLM) computer programs for the construction of digital aliquot parts.
Trans - Alaska Pipeline "Land Records Information Section, Division of Support, Department of Natural Resources (DNR)"	The route of the Trans-Alaska Pipeline was received from Alyeska Pipeline Service Company via the State Pipeline Coordinator's Office.
Who's Planning Alaska University of Alaska Fairbanks Agricultural and Forestry Experiment Station; Cooperative Extension Service	"Who's Planning Alaska is a directory intended to provide documentation to assist professionals and non-professionals with planning in Alaska. It is divided into four major planning groups: Native corporations, municipalities, state agencies, and federal agencies; an emphasis is placed on land use type plans. "
"Pollution: Water, Solid Waste,	
Alaska Certified Pesticide Applicators Alaska Department of Environmental Conservation	"All people who are trained to use pesticides are recorded in this database. It includes their name, certification number, and their certification expiration. "
Alaska Watershed Monitoring and Assessment Project (AWMAP) Directory "Water Quality Protection. Air and Water Quality Division, Alaska Department of Environmental Conservation"	"The AWMAP Directory identifies the locations, waterbodies, and types of monitoring that are being conducted or planned by companies, governmental agencies, municipalities, and others involved in water quality monitoring in Alaska. The Directory is an important reference device used for further development of the Watershed Protection Approach, which includes comprehensive monitoring and assessment strategy. When inquiring with regard to a specific watershed, it is very helpful to know the general location. This database is used to track organizations and what type of monitoring they are doing. The DEC has divided the state into hydrologic units in this dataset. Water body information, parameters such as turbidity, conductivity, and organics are also provided. "

Dataset ID	Description
Alaska's 1996 Water Quality Assessment Report "Division of Air and Water Quality, Alaska Department of Environmental Conservation"	"The DEC is required to submit this report in order to comply with sections of the federal Clean Water Act. This report includes a water quality summary that provides guidance to states for the consistency and utility of reported water quality information. Major sections deal with the following: 1) pollutant sources affecting water quality, 2) the water quality assessment process, 3) 1996 waters of concern, and 4) a list and prioritization schedule for waters of concern. "
Beach Segments- Exxon Valdez Oil Spill Alaska Department of Natural Resources; Exxon	This dataset digitally depicts the Exxon beach segment numbering system used to link work performed on beaches for the official record during the Exxon Valdez Oil Spill cleanup. Segments are divided into subsegments. This segmentation system was used as the geographic base for many response databases. This data was used to provide a standardized geographic base from which the response team could track oil spill cleanup activities.
Biennial Reporting System U.S. Environmental Protection Agency	"BRS is a national system that collects data on the generation, management, and minimization of hazardous waste. This system stores detailed data on the generation of hazardous waste from large quantity generators and data on waste management practices from treatment, storage, and disposal facilities. "
"Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS)" U.S. Environmental Protection Agency	"CERCLIS is the official repository for non-site and site specific Superfund data. This system contains information on hazardous waste site assessment and remediation from 1983 to present. The purpose of CERCLIS is to report official Superfund accomplishments to Congress and the public, and it assists the EPA in evaluating the status and progress of site cleanup activities; it is used to track Superfund Comprehensive Accomplishments Plan, and it communicates planned activities and budgets. "
Daily Shoreline Assessment "Exxon Valdez Oil Spill Restoration Office, Alaska Department of Environmental Conservation"	"This database was developed to track daily shoreline assessments done by ADEC monitors following beach treatment. Data are referenced to beach segment and subdivision and includes treatment type, condition after treatment, oiling observed, equipment used, and names of agency representatives present. "
Directory of Permits Alaska Department of Environmental Conservation	"Permits required at the local, state, and federal levels are listed in this directory. The following information is provided for most permits listed in the directory: purpose, description, requirements, legal authority, and a point of contact. "
Domestic Waste Water Alaska Department of Environmental Conservation	Records for statewide domestic wastewater projects are maintained at the Anchorage area office.
Emergency Response Notification System (ERNS) U.S. Environmental Protection Agency; Department of Transportation Research and Special Programs	ERNS is a database used to standardize and collect notifications made to the Federal government of releases of oil and other hazardous substances. Notification data are used to determine appropriate Federal response action. The system also supports other EPA programs.
Exxon Coastline - Exxon Valdez Oil Spill Database "Exxon; Alaska Department of Natural Resources; Chugach National Forest, U.S. Forest Service"	"The digital shoreline produced by EXXON through the use of a local mapping firm. This dataset is the 1:60,000 air photo update to the state shoreline produced by USFS and DNR at a scale of 1:63,360 using the coastline from USGS 1: 63,360 map series and 1:31,360 timbertype map base. The intended use of this dataset was to provide an accurate, detailed, and updated shoreline for use in resource mapping and analysis for the Exxon Valdez Oil Spill damage assessment and restoration efforts, that would be used by all agencies working in the spill effected area."

Dataset ID	Description
Exxon Valdez Oil Spill Beach Signoff "Exxon Valdez Oil Spill Restoration Office, Alaska Department of Environmental Conservation"	"This dataset was used to track shoreline segments to be reassessed, signed off as clean, or those needing further work. All data are referenced to beach segment and subdivisions."
Exxon Valdez Oil Spill Post-Treatment Assessment Beachwalk "Exxon Valdez Oil Spill Restoration Office, Alaska Department of Environmental Conservation"	"dataset produced from the first post-treatment beach survey conducted by ADEC to assess the shoreline condition after 1989 summer cleanup operations. Data are referenced to beach segments and includes degree and type of oiling, oil penetration, and biological data observed to include birds, mammals, and intertidal barnacles."
Exxon Valdez Oil Spill Spring Shoreline Assessment Team "Exxon Valdez Oil Spill Restoration Office, Alaska Department of Environmental Conservation"	"This dataset documents the 1990 joint pretreatment walking survey of the Exxon spill impact area. This was intended to provide a basis for agreement between the principal parties on the scope of additional work during the 1990 treatment season. Surface and subsurface oil conditions were recorded, along with maps and sketches depicting the location, coverage, and characteristics of remaining oil. Data are referenced by beach segments and subdivision."
Formerly Used Defense Site Database U.S. Army Corps of Engineers	"This national database contains cleanup information for formerly used defense sites which the U.S. Army Corps of Engineers is cleaning throughout the United States. The following information can be found here: 1) site location, 2) site history, 3) site owner, 4) contaminants, and 5) cleanup progress at the site. "
Ground Water Site Inventory (GWSI) "Water Resources Division. U.S. Geological Survey"	"Request information can be obtained for 189 locations in the state and up to 20,000 wells and water holes throughout the state. The database stores up to 300 components on each well or water hole. For every groundwater site standard components will be listed such as: latitude and longitude, use of well or hole, type of groundwater, date well/hole completed, depth, lithological information, owner, legal description, and many other items. "
Intertidal Study Sites-Exxon Valdez Oil Spill Data University of Alaska Fairbanks; Alaska Department of Natural Resources	"The database consists of UAF intertidal study sites in the Exxon Valdez spill affected area. The intended purpose of this database is to provide a resource for use in the oil spill damage identification, oil spill response, habitat restoration activities."
Master Oil Spill Database "Exxon Valdez Oil Spill Restoration Office, Alaska Department of Environmental Conservation"	"The master oil spill database was developed to track oiled shoreline conditions and the work performed on those shorelines. Data include transects, photos and videos, survey team members, etc. Data are referenced to survey stations and beach segments and subdivisions."
National Listing Fish and Wildlife Consumption Advisories Data Base U.S. Environmental Protection Agency	"This database is a national inventory of current wildlife and fish consumption advisories. Fish consumption advisories are a good indicator of the condition of a watershed because they can represent the bioaccumulation of toxic substances in both fish and shellfish. When fish contamination levels exceed safe levels States will sometimes issue advisories to the public recommending some limitations on fish consumption. This database is used to map advisories on a national, regional, state, and watershed basis."

Dataset ID	Description
National Sediment Inventory 1980-1993 U.S. Environmental Protection Agency	"This is the EPA's national assessment of sediment contamination problems in waters throughout the United States. This dataset contains sediment chemistry, sediment toxicity, and fish tissue residue data from many monitoring stations throughout the United States. The EPA applied peer-reviewed weight-of-evidence evaluation to determine the adverse effects to human health or aquatic life indicated by the data provided from monitoring stations. These data are collected to comply with the Water Resources Development Act. "
National Water Quality Inventory U.S. Environmental Protection Agency	"The Clean Water Act requires that Tribes and States adopt designated uses for their waters. This dataset provides information about the magnitude and location of waters that meet Tribal or State designated uses of water quality. Various designated uses are: drinking water supply, aquatic life use support, fish and shellfish consumption, recreation, and agriculture. The Clean Water Act requires that Tribes and States assess and report on the degree to which their surface waters support these uses. The percent of waterbodies meeting their designated uses can be a good indicator of a watershed's condition. "
Permit Compliance System (PCS) U.S. Environmental Protection Agency	"PCS is a national computerized management information system that automates entry, updating, and retrieval of data from the National Pollutant Discharge Elimination System (NPDES). PCS tracks permit issuance, permit limits and monitoring data, and other data pertaining to facilities regulated under NPDES. PCS records water-discharge permit data for more than 75,000 facilities in the United States. Among other things, this database includes information on the pollutants discharged by each facility in excess of limits established in its discharge permit. The watershed loads discharged by facilities can be summed; any excess above the limits established in permits can be calculated from this data for individual facilities and for each watershed in the country."
Permits Alaska Department of Environmental Conservation	"This is the DEC's database for water permits. Various different domestic and non-domestic permits for sewage treatment are included, along with information on non-domestic permits for industrial wastewater sites, and NPDES permits, and watershed permits. In addition, this system is used for water quality classification tracking for 401 and 404 Wetland Fills. "
Pesticide Permits Alaska Department of Environmental Conservation	"This includes herbicide and insecticide permits filed for the most recent year. The following data on the permit are provided: name, date issued, what pesticides were used, and when they were used. Details of permits cannot be found here. "
Public Water System Alaska Department of Environmental Conservation	"This dataset deals with public water systems and specifically, the compliance of public water systems. Data dealing with water requirements, sampling information, enforcement and violations of public water system regulations, inspections and surveys of systems and an inventory of public water systems are included. "
Quality Water Data (QW) "Water Resources Division, U.S. Geological Survey"	"This is USGS's water quality database from samples collected at streams, springs, lakes, and groundwater wells and holes from more than 2,100 surface sites, and over 2,300 well sites and water holes. Chemical, biological, and sediment information is collected for each sample. Temperature and pH are among other parameters included. "
Records of Decisions System (RODS) U.S. Environmental Protection Agency	RODS provides the justification for the remedial action (treatment) chosen under the Superfund program. This data system also stores information on technologies currently being used to clean up sites.
Regdis U.S. Army Corps of Engineers	"404 permitting information is contained in this dataset. 404 permits are required for anyone interested in depositing dredge or filled material into waters/wetlands of the United States. The permit applicant name, year, property owner, waterway effected, the Corps jurisdiction, type of project, size of wetland, and miscellaneous comments are some of the information contained in this database. "

Dataset ID	Description
Resource Conservation and Recovery Information System (RCRIS) U.S. Environmental Protection Agency	"RCRIS is a national program inventory and management system of hazardous waste handlers. RCRIS contains identification and location data for all handlers and a range of information of Treatment, Storage, and Disposal (TSD) facilities is also available. Such data include: permit/closu status, compliance with Federal and State regulations, and cleanup activities. "
Safe Drinking Water Information System (SDWIS)-Source Water Quality Indicators Community "Office of Groundwater and Drinking Water, U.S. Environmental Protection Agency"	This dataset provides a partial picture of impaired source waters that prompt community water systems to add additional treatment or take other action. SDWIS is a repository of information on community water systems that are regulated under the Safe Drinking Water Act (SDWA). This dataset is used to: 1) support implementation and enforcement of the drinking water program; 2) characterize progress of the regulatory program and effectiveness in terms of public health protection; and 3) it is the major source of information for the EPA's environmental indicators. Make a written request with the FOIA officer.
"Shoreline Oiling 1989, Month to Month" Alaska Department of Natural Resources; Alaska Department of Environmental Conservation	"This GIS database was produced as a result of the Exxon Valdez Oil Spill for Natural Resources Damage Assessment (NRDA). Data were collected under the supervision of the Alaska Department of Environmental Conservation (ADEC) with the goal to map and monitor all known locations of beached oil. The ADEC cumulative shoreline oiling through August 1989 provided NRDA with the most comprehensive shoreline oiling data. These observations were based on fixed-wing, helicopter, and on-site records made by a limited number of trained ADEC personnel and backed by a formal ADEC documentation process. The information represents the cumulative oil impact from March 28, 1989 to the end of the month which was reported. The intended use of the dataset is for spill damage
Shoreline Oiling Change 1989-1990 - Exxon Valdez Oil Spill Alaska Department of Natural Resources; Alaska Department of Environmental Conservation	"Shoreline oiling for spring 1990 at a scale of 1:63,360. This is a multi-theme integration GIS database produced as a result of the Exxon Valdez Oil Spill for Natural Resources Damage Assessment (NRDA). The data was collected under the supervision of the Alaska Department of Environmental Conservation (ADEC) with the goal to map and monitor all known locations of beached oil. The 1990 shoreline oiling ADEC used low-altitude aerial observations. The scale is 1:63,360. The intended purpose of this database is to provide a resource for use in the oil spill damage identification, oil spill response, habitat restoration activities."
Shoreline Oiling Fall 1989-Exxon Valdez Oil Spill Alaska Department of Natural Resources; Alaska Department of Environmental Conservation	"Shoreline oiling at a scale of 1:63,360. The fall data represented a summary of beached oil concentrations following the completion of all major spill treatment in 1989. Survey dates were from September 11, 1989 through November 3, 1989. Surveys were conducted by on-site transects, primarily at low tide. ADEC's goal was to map and monitor all known locations of beached oil. Oiling data were verified with ADEC to assure the accuracy of Natural Resources Damage Assessment files. "
Shoreline Oiling Spring 1990-Exxon Valdez Oil Spill Alaska Department of Natural Resources; Alaska Department of Environmental Conservation	"The 1990 spring survey was conducted between March 23, 1990 and June 7, 1990. Surveys were conducted by representatives from the State of Alaska, U.S. Coast Guard, local landowners, and Exxon Corporation. The survey was intended to include all areas of shoreline oiling. The intended use of this database is to provide a resource for use in the oil spill damage identification, oil spill response, habitat restoration activities."
Shoreline Oiling Spring 1991 - Exxon Valdez Oil Spill Alaska Department of Natural Resources; Alaska Department of Environmental Conservation	"The 1990 spring survey was conducted between March 23, 1990 and June 7, 1990. Surveys were conducted by representatives from the State of Alaska, U.S. Coast Guard, local landowners, and Exxon Corporation. The survey was intended to include all areas of shoreline oiling. The intended use of this database is to provide a resource for use in the oil spill damage identification, oil spill response, habitat restoration activities."

Dataset ID	Description
Shoreline Oiling Summer 1989 - Exxon Valdez Oil Spill Alaska Department of Natural Resources: Alaska Department of Environmental Conservation	"This GIS database was produced as a result of the Exxon Valdez Oil Spill for Natural Resources Damage Assessment (NRDA). Data were collected under the supervision of the Alaska Department of Environment Conservation (ADEC) with the goal to map and monitor all known locations of beached oil. During the summer 1989 shoreline oiling ADEC used low-altitude aerial observations. The scale is 1:63,360. The intended purpose of this database is to provide a resource for use in the oil spill damage identification. oil spill response, habitat restoration activities. "
Solid Waste Database Alaska Department of Environmental Conservation	"Solid waste facility name, type, location, owner, permit number, permit expirations, monitoring information, and inspections are stored in this database. This is used to track time the DEC spends on facilities. "
Spills Alaska Department of Environmental Conservation	"Records for all spills reported in the State are recorded in this database. General fields included are: spill date, size, location, substance, cause, source, and minimal cleanup information. "
STORET U.S. Environmental Protection Agency	"STORET is the EPA's national database designed to collect and disseminate basic information on chemical, physical, and biological quality of the nation's waters: Ambient, intensive survey, and effluent water quality data are available. The ambient concentration of selected toxic pollutants (mercury, lead, cadmium, and copper), and selected conventional pollutants (ammonia, BOD, nitrogen, phosphorus, and suspended sediment) are indicated. The level of toxic and conventional pollutants in waterbodies is a good indicator of current water quality problems in a watershed. "
Task Force on Erosion Control Alaska Department of Transportation and Public Facilities	"This report identifies and prioritizes erosion problems throughout the state. It includes, but is not limited to the following: 1) maintenance responsibility of the community, 2) question of state liability for proposed erosion, 3) relationships of other water front capital projects to erosion control projects, and 4) effect of projects on beach users. Some community erosion reports are also available here. "
The Hazards Database Alaska Department of Environmental Conservation	"Historical accounts of contaminated sites, leaking underground storage sites, and hazardous waste sites are recorded here. Specific locations of these sites are also recorded, including latitude and longitude information for some sites. "
Toxic Release Inventory System (TRIS) U.S. Environmental Protection Agency	"TRIS contains information about release and transfers of well over 300 toxic chemicals and compounds to the environment. TRIS is part of the relational database, Envirofacts. Release-transfer data are stored hierarchically by facility, by year and chemical, and by medium of release (such as air, water, land disposal, etc.). It also stores treatment and source-reduction data. Data are stored at the facility level, the chemical level, and pollution prevention data."
U.S. Underground Storage Tank Database "Alaska Department of Environmental Conservation, U.S. Environmental Protection Agency"	"Various underground storage tank information is available in this database, such as: 1) owner information, 2) facility location and information, 3) tank status, capacity, etc., and 4) compliance and enforcement data. The Alaska Department of Environmental Conservation provides a standard report of all underground storage facilities in Alaska that is available on the internet. "
Village Safe Water "Village Safe Water, Division of Facility Construction and Operation, Alaska Department of Environmental	"Files of individual projects dealing with village water are in this dataset. Each project must be looked at individually and information on things such as design, planning, water source, monitoring system, and flow demand may be contained in these files. "

Dataset ID	Description
Waste Minimization Measurement Project Alaska Department of Environmental Conservation	Data obtained from a statewide survey on waste minimization efforts are stored here.

Recreation

Administrative Information Database "Division of Refuges, U.S. Fish and Wildlife Service"	"This database is part of the Refuge Management Information System (RMIS). Each refuge's name, mailing and shipping address, manager name, and a short description of the refuge are contained here."
Public Education and Recreation Database "Division of Refuges, U.S. Fish and Wildlife Service"	This database is part of the Refuge Management Information System (RMIS). It is used to track the number of people who visit refuges and their activities in the refuges.
Recreational Fisheries and Biology "Sport Fish Division, Alaska Department of Fish and Game"	"Data on catch, harvest, and participation in Alaska's recreational fisheries and the abundance, composition, dynamics, growth, and productivity of the associated fish populations. "

Vegetation Information (including aerial

Advanced Very High Resolution Radiometer (AVHRR) National Oceanic and Atmospheric Administration (NOAA)	"AVHRR data are collected from NOAA's Polar Orbiting Environmental satellites. There are approximately 25,000 images of the State of Alaska and adjacent waters in the AVHRR archive at the University of Alaska Fairbanks Geodata Center."
Alaska (AVHRR) Twice Monthly Composites "Earth Science Information Center, EROS Data Center, U.S. Geological Survey"	"Alaska AVHRR dataset is comprised of twice-monthly maximum Normalized Difference Vegetation Index (NDVI) composites created from daily NOAA-11 satellite observations. The goal of the Alaska AVHRR project is to compile a comprehensive time series dataset of calibrated, georegistered daily observations and twice monthly maximum NDVI composites for each annual growing season. This data set has applications for environmental monitoring and assessing impacts of global climate change. "
Alaska High Altitude Aerial Photography National Areonautics and Space Administration (NASA)	"Hardcopy 9""X9"" frames of high-altitude (65,000 ft.) aerial photography flown on prescribed flight lines by NASA 1978-1986, in support of scientific research projects throughout Alaska. Snow free photography with less than 10% shadow and cloud cover. Photography flown between June 15 and August 30. The minimum sun angle is 30 degrees. "
Alaska Interim Land Cover Mapping "Alaska Field Office, EROS Data Center, U.S. Geological Survey"	Statewide landcover mapping effort to produce regional scale landcover mapping over the entire state using Landsat satellite data. This project integrated a variety of landcover mapping efforts conducted by a variety of state and federal agencies for a variety of resource inventory projects.

Dataset ID	Description
Alaska Plant Collection "Northern Plant Documentation Center, Herbarium, University of Alaska Museum, University of Alaska Fairbanks"	"Database of plant specimen label data from the Herbarium of the University of Alaska Museum. Most records include latitude/longitude coordinates. The database is used primarily to produce rangemaps and checklists. It is also a botanical database designed to store data on nomenclature and specimens. This database supports the Alaska vascular and nonvascular plant collection at the University of Alaska Herbarium. Contains the following related files: names, infgenera, genera, families, rcode, authors, localities, specimens, collectors, literature, exsiccatae, voucherref, and params. "
Alaska Quick Look Landsat Imagery "Geophysical Institute, University of Alaska Fairbanks"	"Alaska Quick Look is black and white imagery taken from Landsat satellites during off hours when the satellites were at oblique angles to the earth. The photos were taken for research purposes at the University of Alaska, Fairbanks. "
Forest Health Management Report U.S. Forest Service	"Forest insect and disease activities are summarized in this report. The status of insects and diseases, declines and abiotic factors, and the status of animal damage are the primary focus of the report. In addition, integrated pest management activities and procedures for submitting insects or diseases for identification are provided. "
Forestry Inventory and Analysis Database U.S. Forest Service	"This inventory is not yet complete, but presently two-thirds of the lands in Alaska have been inventoried. The Forest Service must update this every 10 years and submit the inventory to Congress. "
Land Cover Prince William Sound and Kenai Peninsula-Exxon Valdez Oil Spill "Alaska Department of Natural Resources; U.S. Forest Service; EROS Alaska Field Office, U.S. Geological Service"	"Landcover for the Exxon Valdez Oil Spill affected area was extrapolated from DNR Alaska Land and Resource Mapping (ALARM) Program to provide general land cover maps at a scale of 1:250,000 for Prince William Sound and the Kenai Peninsula. Both Landsat Imagery and Aerial photography were used to interpret vegetation types in 10 general classes. More detailed landcover is available for Afognak Island and PWS through the Chugach National Forest. The intended use was to provide landcover information for use in damage assessment, and restoration efforts."
Landsat Mosaics for Alaska "Alaska Field Office, EROS Data Center, U.S. Geological Survey"	"A series of 143 individual MSS Landsat satellite images pieced together to show the State of Alaska. These images are false-color mosaics showing two visible and two infrared data bands. The imagery is available in a choice of formats and prices, based on two photo-reproduction techniques. "
Multispectral Scanner Landsat Data National Aeronautics and Space Administration (NASA)	"A MSS sensor has flown on all five of the Landsats. The first satellite in the Earth Resources Technology Satellite (ERTS) program was launched July 23, 1972. A second satellite followed on January 22, 1975. At that time the program was redesignated as the Landsat program to emphasize its primary area of interest, land resources. The mission of Landsat is to provide for repetitive acquisition of high resolution multispectral data of the earth's surface on a global basis. "
SPOT High Resolution Visible Data Satellite Pour l'Ovservation de la Terre (SPOT)	"The French Earth Observation Satellite, SPOT, produces digital satellite imagery with the highest spatial resolution that is commercially available. Panchromatic (black and white) imagery has a resolution of 10x10 meters, and is commonly used for detailed mapping, feature identification, change detection, and updating of vector files. Multispectral imagery (visible and infrared) has a resolution of 20x20 meters and is used for land use and land cover mapping and natural resource studies. SPOT Image offers its digital ortho-imagery in standard 7.5, 15, and 30 minute map frames. "

Dataset ID	Description
USGS Orthophoto Quads "Earth Sciences Information Center, U.S. Geological Survey (USGS-EISC)"	"Orthophotos are multicolored, distortion-free, photographic images. Unlike a normal aerial photograph, relief displacement in orthophotos has been removed so that all ground features are displayed in their true ground position. This allows for the direct measurement of distance, areas, angles, and positions. An orthophoto displays features that may be omitted or generalized on maps. They serve a variety of purposes, from interim maps to field references for earth science investigations and analysis. Scale is 1:63,360. "

Wildlife

Alaska Game Management Units "Wildlife Conservation Division, Alaska Department of Fish and Game"	"Database compiled to depict Alaska Fish and Game, Game Management Units Statewide. Other resource management agencies have obtained this coverage for use within their own resource management jurisdiction. U.S. Forest Service Chugach and Tongass National Forests have incorporated a subset of this dataset for their lands and are currently using this dataset within their in-house GIS systems. U.S. National Park Service has done the same. Intended use of this dataset is to aid Fish and Game in resource management."
Alaska Habitat Management Guides "Habitat and Restoration Division, Alaska Department of Fish and Game"	"Wildlife (fish and game) habitat and harvest use areas are portrayed on maps at 1:250,000 and 1:1,000,000 scale in the ""Alaska Habitat Management Guide Atlases". The Southcentral and Southeast volumes cover the Prince William Sound and Glacier Bay Ecosystem initiative areas. Several narrative volumes were also produced for these regions. "
Alaska Landbird Database: Interactive Access to Survey Data on Landbird Breeding Populations and Habitats "Alaska Science Center, Biological Resources Division, U.S. Geological Survey"	"This database contains standardized data on bird distribution, relative abundance, and habitat structure from 130 survey routes across the state. The primary objective of this project is to make up-to-date information readily available to land managers. "
Alaska Mammal Collection "University of Alaska Museum, University of Alaska Fairbanks"	"The Mammal Collection database contains records for 34,000 University of Alaska Museum specimens, most of which are from Alaska. Data include the kinds of information typically associated with museum specimens, i.e. taxonomic identity, locality, date, measurements, reproductive condition, etc. "
Alaska Wildlife Harvest Summary "Wildlife Management Section, Division of Wildlife Conservation, Alaska Department of Fish and Game"	"This book contains a summary of all game harvest information in the State of Alaska. Harvest and hunter information is organized either by species or unit/subunit, and a map of game management units is provided. Historical harvest statistics are provided for several species. Permits, harvest tickets, and license statistics for the year are also provided. "
Bald Eagle Nests - Exxon Valdez Oil Spill Database U.S. Fish and Wildlife Service; Alaska Department of Natural Resources	"This dataset depicts locations of known bald eagle nests. This database is intended to provide a resource for use in the oil spill damage identification, oil spill response, and habitat restoration activities. "
Breeding Waterfowl and Habitat Survey U.S. Fish and Wildlife Service	This dataset consists of counts of ducks and ponds seen by observers conducting fixed-wing aerial surveys. The purpose of the dataset is to estimate annual breeding population size of several waterfowl species and to quantify breeding habitat conditions.

Dataset ID	Description
Threatened and Endangered Species Data "Division of Refuges, U.S. Fish and Wildlife Service"	"Lists of taxonomic groups of species and names on the Threatened and Endangered List are contained in this database. They are categorized as: threatened, endangered, or candidate; and it states whether the species is state or federally listed. Some cases included information on critical habitat, acreage used, season of use, and population levels. "
Wildlife Population Statistics Alaska Department of Fish and Game	Population statistics are available in report form for individual wildlife. You must make a request for the specific wildlife you are interested in.

Revision 9-29-98

1998 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET
October 1, 199o - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999	PROPOSED FY 1999 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
			$88.7		$238.7	$7.6		
Personnel	$0.0	$166.7						
Travel	$0.0	$4.0						
Contractual	$0.0	$130.0						
Commodities	$0.0	$0.2						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$300.9		Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
General Administration	$0.0	$34.1						
Project Total	$0.0	$335.0		$600.0	$0.0	$0.0		
Full-time Equivalents (FTE)	0.0	2.4						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0		$0.0	$0.0	$0.0		

Comments: This project will develop an integrated data base containing digital environmental and spatial data for the Cook Inlet watershed. The proposed system will facilitate access to significant amounts of disparate data from a wide variety of sources about the resources and services injured by the Exxon Valdez Oil Spill as well as base data sets important to understanding the environment of the watershed. This database and its associated retrieval system will support monitoring, management and restoration of resources and services injured by the Exxon Valdez Oil Spill. The system will provide access to data, graphics, images, text and documents for users in both the public and private sectors. It will relate current, historical and future data sets thereby improving data availability, access, and integration. The system will enable syntheses, environmental analyses, planning and natural resources management. Water quality data sets derived from the watershed will provide the cornerstone of this system thereby facilitating monitoring of both baseline parameters and chronic sources of marine pollution that may be affecting recovery of injured resources and services. From both public policy and natural resources management perspectives, this project will protect the governments' investment in restoration by making information derived from restoration activities and water quality monitoring programs available for management of the watersheds in a manner that will promote the recovery of the injured resources and services.

1999

Project Number: 99391
Project Title: CI/PWS Information Management/Monitoring System
Lead Agency: AK Dept. of Environmental Conservation and Natural Resources

FORM 2A
MULTI-TRUSTEE AGENCY SUMMARY

1998 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$74.4
Travel		$2.9
Contractual		$0.0
Commodities		$0.2
Equipment		$0.0
Subtotal	$0.0	$77.5
General Administration		$11.2
Project Total	$0.0	$88.7
Full-time Equivalents (FTE)		1.1
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
	$180.0				

Dollar amounts are shown in thousands of dollars.

Comments:

1999

Project Number: 99391
Project Title: CI/PWS Information Management/Monitoring System
Lead Agency: AK Dept. of Environmental Conservation

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1999
TBD	Analyst Programmer III	17	12.0	5.6		67.2
Jeff Hock	Environmental Specialist IV	20	1.0	7.2		7.2
Russell Kunibe	Analyst Programmer IV	19	0.0	6.9		0.0
	Student Intern		0.0	2.2		0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		13.0	21.9	0.0	
					Personnel Total	$74.4

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1999
					0.0
Travel to Anchorage to meet with cooperators.	0.45	3	6	0.15	2.3
					0.0
Travel to Kenai to meet with Stakeholders, municipal gov. and public	0.11	1	3	0.15	0.6
					0.0
Travel to Valdez to meet with Stakeholders, municipal gov. and public	0.18	0	4	0.00	0.0
					0.0
Travel to Cordova to meet with Stakeholders, municipal gov. and public	0.20	0	2	0.00	0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.9

1999

Project Number: 99391
Project Title: CI/PWS Information Management/Monitoring System
Lead Agency: AK Dept. of Environmental Conservation

FORM 3B
Personnel
& Travel
DETAIL

Prepared: 9/29/98

1998 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Contractual Costs:	Proposed FY 1999
Description	
Air Charter and Boat Charters needed to access local communities for project input.	
Boat Charters (Cook Inlet), 20 hours @ $70 hour.	0.0
Air Charters, 20 hours @ $250 hour.	0.0
Boat Charters (PWS), 4 days @ $400/day.	0.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed FY 1999
Description	
Office Supplies (paper, toner cartridges, etc.)	0.2
Computer support materials (storage media, plotter cartridges, plotter paper, cabling, routers).	0.0
Commodities Total	$0.2

1999

Project Number: 99391
Project Title: CI/PWS Information Management/Monitoring System
Lead Agency: AK Dept. of Environmental Conservation

FORM 3B
Contractual & Commodities DETAIL

Prepared: 9/29/98

1998 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1999
Arc View License	0	1.3	0.0
Relational DB License	0	15.0	0.0
Server	0	20.0	0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.	**New Equipment Total**		$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1999

Project Number: 99391
Project Title: CI/PWS Information Management/Monitoring System
Lead Agency: AK Dept. of Environmental Conservation

FORM 3B
Equipment
DETAIL

Prepared: 9/29/98

1998 EXXON VALDEZ TRU! COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999						
Personnel		$86.0						
Travel		$0.7						
Contractual		$130.0						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$216.7		Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
General Administration		$22.0						
Project Total	$0.0	$238.7		$360.0				
Full-time Equivalents (FTE)		1.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1999

Project Number: 99391
Project Title: CI/PWS Information Management/Monitoring System
Agency: AK Department of Natural Resources

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: 6 of 13

9/29/98

1998 EXXON VALDEZ TRU[illegible] COUNCIL PROJECT BUDGET

October 1, 199[illegible] - September 30, 1999

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1999
Kelly Zeiner / TBD	Analyst Programmer III	17	12.0	5.8		69.6
TBD	Student Intern, 1 part time annually		0.0	1.1		0.0
TBD	Student Intern, Full time summer		0.0	2.2		0.0
Dorothy Mortenson	Analyst Programmer IV	19	0.0	6.2		0.0
Patty Bielawski	Special Assistant	23	2.25	7.3		16.4
TBD	Natural Resource Manager	20	0.0	7.2		0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		14.3	29.8	0.0	
					Personnel Total	$86.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1999
					0.0
Travel to local communities	0.2	2	2	0.15	0.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.7

1999

Project Number: 99391
Project Title: CI/PWS Information Management/Monitoring System
Agency: AK Department of Natural Resources

FORM 3B
Personnel
& Travel
DETAIL

Prepared: 9/29/98

1998 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Contractual Costs:	Proposed
Description	FY 1999
Facility rental, postage, printing costs associated with User Analysis Workshop	5.0
Data Conversion, Data Cleanup, Data Documentation	0.0
Consulting Services for development and implementation of:	110.0
User Needs Analysis	
Database Model	
Rapid Prototype	
Data Integration	
Prototype Evaluation, Refinement	
Consulting Services / User Needs Analysis Workshop (principal investigators, 4 days, travel, per diem)	15.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$130.0

Commodities Costs:	Proposed
Description	FY 1999
Plotter Paper	0.0
Storage Media	0.0
Software upgrades	0.0
Commodities Total	$0.0

1999

Project Number: 99391
Project Title: CI/PWS Information Management/Monitoring System
Agency: AK Department of Natural Resources

FORM 3B
Contractual & Commodities DETAIL

Prepared: 9/29/98

1998 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1999
			0.0
Desktop PC, Pentium Processor	0	5.0	0.0
ArcView License w spatial analyst	0	3.0	0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.	**New Equipment Total**		$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1999

Project Number: 99391
Project Title: CI/PWS Information Management/Monitoring System
Agency: AK Department of Natural Resources

FORM 3B
Equipment
DETAIL

Prepared: 9/29/98

1998 EXXON VALDEZ TRU[illegible] COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999						
Personnel		$6.3						
Travel		$0.4						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$6.7		Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
General Administration		$0.9						
Project Total	$0.0	$7.6		$60.0				
Full-time Equivalents (FTE)		0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1999

Project Number: 99391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US Forest Service

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: 10 of 13

9/29/98

1998 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1999
						0.0
L. Suring	Wildlife Biologist	12	1.0	6.3		6.3
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.0	6.3	0.0	
					Personnel Total	$6.3

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1999
					0.0
Travel to Soldotna/Homer/Kenai	0.1	1	2	0.15	0.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.4

1999

Project Number: 99391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US Forest Service

FORM 3B
Personnel
& Travel
DETAIL

Prepared: 9/29/98

1998 EXXON VALDEZ TRU! COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Contractual Costs:	Proposed FY 1999
Description	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed FY 1999
Description	
Commodities Total	$0.0

1999

Project Number: 99391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US Forest Service

FORM 3B
Contractual & Commodities DETAIL

Prepared: 9/29/98

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

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1999

Project Number: 99391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US Forest Service

FORM 3B
Equipment
DETAIL

Prepared: 9/29/98

PROJECT 99391 / COOK INLET INFORMATION MANAGEMENT AND MONITORING SYSTEM

99391 Phase I Budget by agency

	ADEC	ADNR	USFS	Total
Personnel	$33.4	$36.3	$6.3	$76.0
Travel	$2.1	$0.7	$0.4	$3.2
Contractual	$0.0	$75.0	$0.0	$75.0
Commodities	$0.2	$0.0	$0.0	$0.2
GA	$5.0	$10.7	$0.9	$16.6
Total	$40.7	$122.7	$7.6	$171.0

99391 Phase II Budget by agency

	ADEC	ADNR	USFS	Total
Personnel	$41.0	$49.7	$0.0	$90.7
Travel	$0.8	$0.0	$0.0	$0.8
Contractual	$0.0	$55.0	$0.0	$55.0
Commodities	$0.0	$0.0	$0.0	$0.0
GA	$6.2	$11.3	$0.0	$17.5
Total	$48.0	$116.0	$0.0	$164.0

Project Total **$335.0**

Submitted 10/13/98

Revised 7-6-98
Approved TC 12-15-98

Prince William Sound Food Webs: Structure and Change

Project Number:	99393-BAA
Restoration Category:	Research
Proposer:	T. Kline/PWSSC
Lead Trustee Agency:	NOAA
Cooperating Agencies:	None
Alaska SeaLife Center:	No
New or Continued:	New
Duration:	1st yr. 3 yr. project
Cost FY 99:	$125.0
Cost FY 2000:	$143.6
Cost FY 01:	$114.6
Cost FY 02:	$0.0
Geographic Area:	Prince William Sound
Injured Resource/Service:	Fish

ABSTRACT

Recent research has shown that the oceanographic conditions connecting the northern Gulf of Alaska with Prince William Sound may affect recruitment and nutritional processes in fishes. Accordingly, food webs are subject to changes in carbon flow occurring between the Gulf of Alaska and Prince William Sound. This project seeks to (1) conduct retrospective analysis of Gulf of Alaska production shifts since the oil spill and (2) address Ecopath model validation data gaps. These analyses will enable a better understanding of the ecological role of regime shift processes conjectured to be impeding the natural restoration of populations in Prince William Sound affected by the oil spill.

INTRODUCTION

Stable isotope ratios of carbon and nitrogen have been shown to serve as effective tracers of energy supply in the Prince William Sound study area (Kline 1997a, 1997b, 1998a, 1998b) This is due to (1) the conservative transfer of carbon isotope ratios between the lower tropic levels (phytoplankton to zooplankton to forage fishes, etc.) of Prince William Sound (PWS) and adjacent Gulf of Alaska (GOA) waters up to the top consumers and (2) the naturally occurring gradient in $^{13}C/^{12}C$ productivity generated in the Gulf compared with the Sound. Organisms acquire these isotope ratios in response to the importance of the food in bulk body tissues. Isotope ratio analysis of tissues thus provide insight into both habitat usage and assist in quantifying amounts derived from various areas. Nitrogen isotope ratios, in turn, provide excellent definition of relative trophic level. The heavy isotope of nitrogen is enriched by about 0.3 % with each trophic level and thus can accurately indicate the relative trophic status of species within an ecosystem (Minagawa and Wada 1984, Fry 1988) and is useful for food web model validation (Kline and Pauly 1998; Kline 1998b).

Results from prior work

Juvenile herring and pollock are the dominant pelagic fishes in PWS and both consume zooplankton. Juvenile herring and pollock from PWS shifted in $^{13}C/^{12}C$ content between 1994 and 1995 from which a change in carbon source dependency was inferred (Fig. 1). Although both species shifted in concert to greater GOA dependency in 1995 than 1994, pollock were consistently less dependent on GOA carbon. Juvenile pollock and herring occupy different levels in the water column, have different schooling behavior, and recruit from the larval stage at different times, effecting access to a different forage-base as confirmed by the data. This difference may not be reflected in the species composition of diet but instead the where and when of the production cycle as integrated into the isotopic signature (Kline 1998), which reflects the assimilated carbon pool of the fish. The greater reliance on GOA-derived carbon in herring may reflect their dependence on carbon generated later in the season during the time when advection of GOA production was nearly the sole carbon source in 1995 as suggested by the data (Fig. 1). The concordant shift to greater GOA dependency by both species in 1995, Sound-wide, implied that system-wide bottom-up effects permeated the whole ecosystem due oceanographic processes.

The isotopic gradient between PWS and GOA had a consistent relationship in the 1994-1996 period except for May 1996 when the gradient reversed owing to a large magnitude change in the GOA signature (Fig. 2). Whereas PWS mean $^{13}C/^{12}C$ values ranged within 1 delta unit, and the difference between PWS and GOA averaged 3 delta units, the GOA mean value shifted in Spring 1996 by 5 delta units. This large shift reflected a change in phytoplankon fractionation during uptake of CO_2 which varies as a function of growth

rate (Laws et al. 1995, Bridigare et al. 1997). Thus the productivity pattern during the spring bloom of 1996 was markedly different from other times. Large fluctuations in productivity in the GOA suggests large inconsistencies in food availability for consumers from year to year if these fluctuations are typical. Thus the question arises : Are fluctuations in GOA spring bloom productivity, as evidenced by changes in $^{13}C/^{12}C$, typical?

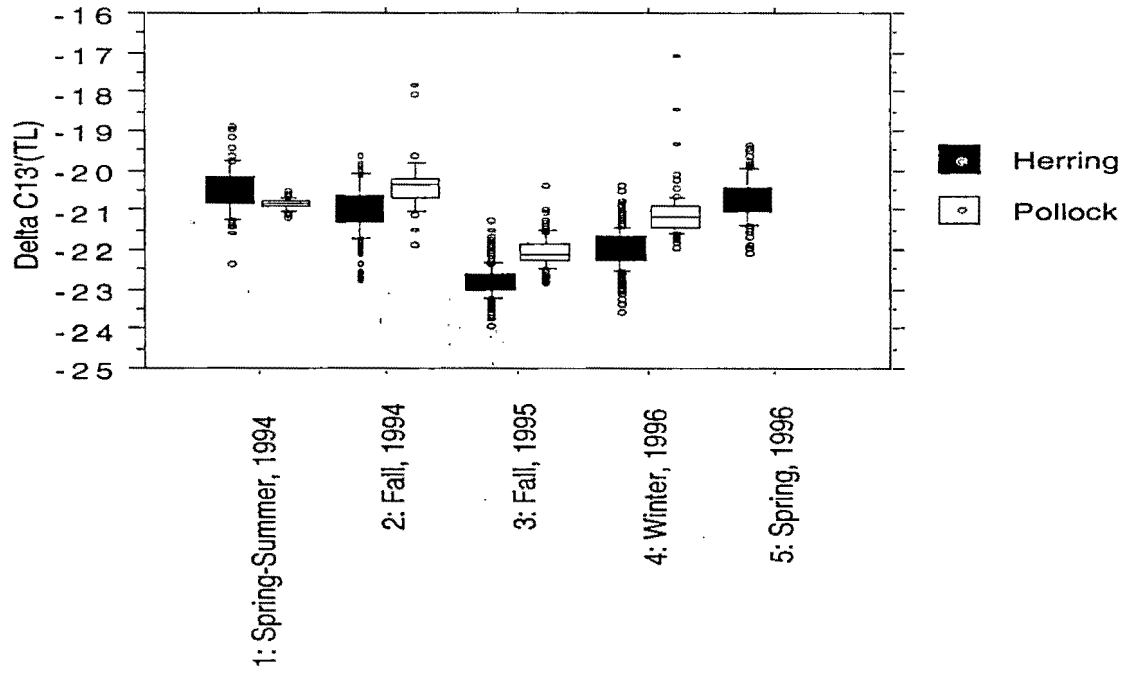

Figure 1. Shift in $^{13}C/^{12}C$ and inferred change in Gulf of Alaska (GOA) vs. Prince William Sound (PWS) carbon dependency (see Kline 1998b, for explanation of delta notation and method of data interpretation) of juvenile herring and pollock in 1994 - 6 (from Kline 1998a). The distribution of values are shown as box and whisker plots that denote the 10th, 25th, 50th, 75th, and 90th percentiles; ouliers are shown as symbols. There was a large shift to greater GOA carbon dependency in 1995 for both species as indicated by the large change between the Fall of 1994 and the Fall of 1995.

The Ecopath modeling group (Pauly and Pimm et al.) Trustee Council sponsored synthesis of known ecological relationships of many of the organisms inhabiting PWS will be used to conduct perturbation experiments to examine EVOS and restoration effects. The utility of this effort will in part be dependent on how realistic their models are. One way to determine if the model is realistic is to compare model predictions with those made using an independent method. Ecopath generates as part of the output, the fractional trophic level for each functional group defined in the model input that can be validated with $^{15}N/^{14}N$ data (Kline and Pauly 1998). Kline and Pauly (1998) validated a preliminary PWS Ecopath model using this novel approach. They used a limited number of functional groups (Fig. 3) which contrasts with the full Ecopath model which will have ~ 50. In comparison to the preliminary model, the artifact of functional group over-

aggregation will be significantly reduced in the full model, enabling a more robust Ecopath validation if $^{15}N/^{14}N$ data for a large proportion of the functional groups were available.

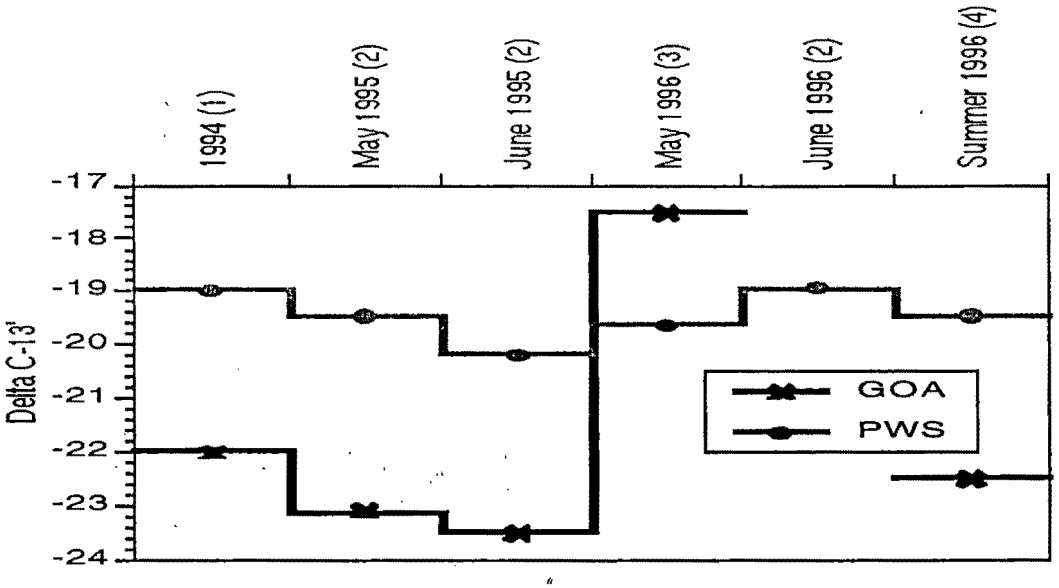

Figure 2. Time series of $^{13}C/^{12}C$ measured in feeding *Neocalanus cristatus* from Prince William Sound (PWS) and the Gulf of Alaska (GOA). Points reflect mean values, standard deviations were 0.5 to 1 delta units. PWS and GOA values were consistently statistically different (Kline 1998a, 1998b).

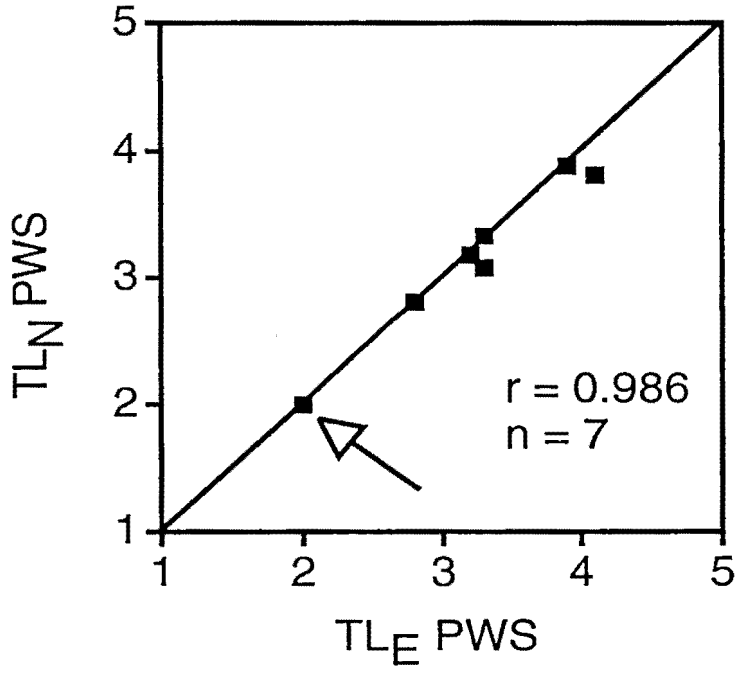

Figure 3. An example of using trophic level determined by $^{15}N/^{14}N$ content (TL_NPWS) to validate trophic level predicted by Ecopath modeling (TL_EPWS). The Arrow indicates the calibration point, remaining points are the estimated trophic level values for six Ecopath functional groups. From Kline and Pauly (1998).

NEED FOR THE PROJECT

A. Statement of Problem

The Problem: Recovery of EVOS damaged species is uncertain in light of regime shifts

Decadal-scale changes in the production cycles of the subarctic Pacific Ocean have been conjectured to effect population changes in fishes and their zooplankton forage base (Brodeur and Ware 1992, Francis and Hare 1994). A "ring of zooplankton" occurring near the Gulf of Alaska (GOA) continental shelf break appears to undergo dramatic oscillations in abundance over decadal time scales (Brodeur and Ware 1992). This "ring of zooplankton" is driven onto the shelf providing the ecosystem with an important forage base (Cooney 1988, 1993). Natural stable isotope (NSI) data suggested that the transport of zooplankton from the GOA into Prince William Sound (PWS) may provide significant quantities of forage for food webs and may be a good method for detecting changes in biophysical coupling in the PWS region (Kline 1998b).

A recent "regime shift" similar to that seen in the past (Brodeur and Ware 1992, Francis and Hare 1994) is conjectured to be presently occurring in the North Pacific (Anderson et al. 1996). Post-EVOS recoveries are uncertain since the regime shift may impede population increases. Recently, using NSI, it has been possible to ascertain that GOA primary productivity patterns vary at interannual time scales and that GOA production is important to PWS (Kline 1998b). Using retrospective NSI analysis, it may be possible to assess whether fluctuations in primary production took place since EVOS. If so, this could explain the poor recovery of some injured species. Furthermore, fluctuations in the mass balance of carbon postulated to be taking place can be incorporated into applications of the Ecopath model being developed by Trustee Council funding which can also be validated using NSI data (Kline and Pauly 1998).

Need #1: Gulf of Alaska productivity fluctuations - retrospective analysis since EVOS

There is a discontinuity between the start of PWS ecosystem studies in 1994 and the timing of EVOS in 1979. Ecosystem shifts occurring in the GOA since 1989 were thus not incorporated in present studies. To overcome this perspective, retrospective NSI analyses may enable a reconstruction systematic ecological changes occurring since 1989.A retrospective approach is being used by GLOBEC in several projects in the N.E. Pacific as a means of overcoming temporal limitations in our database (U.S. GLOBEC 1996). Fixed tissues such as the protein layer on the exterior of mussels provide a recent record of changes in the isotopic composition of their phytoplankton diet. An opportunistic collection of *Mytilus californianus* from Middleton Island made in September 1997 provides an inexpensive approach to retrospective analysis. Middleton Island's location in the Alaska Current provides an "upstream perspective" on the EVOS

area since samples from there will reflect changes in plankton upstream before interaction with PWS-origin carbon is possible.

Need #2: Mass-balance modeling validation data gaps

Kline and Pauly (1998) established the utility of using NSI data to validate the Ecopath mass-balance model (Project 330). This was done with a small number of highly aggregated functional groups. The final model will likely have about 40-50 functional groups (Table 1). Of the functional groups listed good isotopic representation is currently available for about 7 (Table 1). Thus confident model validation could only be performed for a limited selection of the functional groups. Additional samples for 17 functional groups are available as archived or stored samples (underlined yes in the column labeled "sample availability") while another 14 functional groups (underlined yes in the column labeled "sample accessibility") could be easily sampled. A total of ~ 40 functional groups providing a good model validation could be made available by augmenting the existing database by analysis of existing samples and additional sampling (Table 1).

Table 1. Ecopath model functional groups as of April 1998 and potential isotopic model validation data (groups 25, 26, and 27 are likely to be dropped from the model. Uncertain functional group size break criteria at time of this writing reflected by question marks. Data courtesy of T. Oakey, Univ. British Columbia.

Functional group	Species	Data availability	Sample availability	Sample accessibility	Final data avail probability
1 Resident Orcas	orca	none	no	no	poor
2 Sm cetaceans	porpoise	none	no	no	poor
3 Adult Herring	herring >?	good	yes	yes	good
4 Juv. Herring	herring < ?	good	yes	yes	good
5 Baleen Whales	humpback	none	no	no	poor
6 Nearshore Pelagics	Juv tom and p cod	fair	no	yes	good
7 Offsh Sm Pelagics	other osmerids, lanternfish, smoothtongue	fair	yes	yes	good
8 Offsh Lg Pelagics	sharks, pel RFs, gadids	fair	yes	yes	good
9 Capelin	capelin	fair	yes	yes	good
10 Sandlance	sandlance	fair	no	yes	good
11 Squid	squid	fair	yes	yes	good
12 Sea otter	sea otter	none	no	no	poor
13 Arrowtooth Adult	arrowtooth fldr >?	poor	yes	yes	good
14 Arrowtooth juv	arrowtooth fldr <?	none	no	yes	good
15 Pollock 3+ age	3+age pollock	good	yes	yes	good

16 Pollock 0 age	0 age pollock	good	yes	yes	good
17 Pollock 1-3 age	1-3 age pollock	fair	yes	yes	good
18 Nearshore Demersal	greenlings, sculpins, gunnels, shanny, ronquils	fair	yes	yes	good
19 Shallow Lg Epibenth.	seastars, crabs	none	yes	yes	good
20 Shallow Sm Epibenth.	mussels, periwinkles, barnacles, limpets, chitons, amphipods, other snails	none	no	yes	good
21 Shallow Lg Infauna	polychaetes	none	no	yes	good
22 Shallow Sm Infauna	clams	none	no	yes	good
23 Mid. Sm Epibenth.	ophioroids	none	no	yes	good
24 Mid Lg Epibenth.	sea pens, crabs	none	yes	yes	good
25 Mid Lg Infauna					
26 Mid Sm. infauna					
27 Deep Sm Infauna					
28 Omniv.-zooplankton	euphausiids, amphipods, larval Fishes, chaetognaths, decapods	fair	yes	yes	good
29 Herb.-zooplankton	copepods, larvaceans, pteropods	good	yes	yes	good
30 Diatoms	diatoms (See McRoy)	fair	yes	yes	good
31 Flagellates	flagellates (See McRoy)	fair	yes	yes	good
32 Macroalgae	kelps, eelgrass	none	yes	yes	good
33 Fish-eating birds	kittiwakes (See Suryam)	fair	yes	yes	good
34 Invert.-eating Bird	(See Bishop)	poor	no	no	good
35 Avian Raptors	eagles	none	no	no	poor
36 Transient Orcas	orca	none	no	no	poor
37 Adult Salmon	salmonidae adult	fair	no	yes	good
38 Pinnipeds	seals, sealions (See Schell)	good	yes	yes	good
39 Salmon Fry 0-6 cm	5 *Oncorhynchus* sp <6cm	fair	yes	yes	good
40 Salmon fry 6-12 cm	5 *Oncorhynchus* sp >6cm	fair	yes	yes	good
41 Meiofauna	infauna < 1mm	none	no	yes	good
42 InshoreDetritus	<20 m(macro alg)	none	no	yes	good
43 Offshr Detritus	>20m (plankton)	none	no	yes	good
44 Rockfishes	*Sebastes* spp.	fair	yes	yes	good
45 Sablefish	sablefish	none	yes	yes	good
46 Lingcod	lingcod	none	yes	yes	good
47 Halibut	halibut	poor	yes	yes	good

48 Herring eggs	herring eggs	none	no	yes	good
49 River otters and minks	(see Ben-David)	good	yes	yes	good
50 Carnivorous jellies	ctenophores, cnidarians	none	yes	yes	good

Urgency and scheduling of analysis in relation to expected delivery of the Ecopath model

There will be a significant time lag from date when funding begins to when data will be available for model validation. First, samples will need to be prepared in the laboratory, converting them into a finely-powdered form. Second, samples will be sent out for mass spectrometry at the University of Alaska Stable Isotope Facility. It takes 6 to 9 months to get NSI data back. Therefore, data are not likely to be available until about a year from start date. Therefore it is imperative that this project commence in the forthcoming fiscal year. To expedite the process, NSI studies will focus on samples already available (yes in the "Sample availability" column in Table 1) in FY99 while FY00 will be used to additional samples accessible through other projects.

B. Rationale/Link to Restoration

Shifts in carbon flow occurring as a result in variations in the physical environment represent fundamental changes in the way the PWS ecosystem supports commercially important species. The availability of macrozooplankton forage for fishes varies in space and time because of changes in physical processes in PWS. The NSI approach is unique in its ability to integrate time and spatial scales at mesoscale levels. No other technique currently available can generate such results. The natural tracer aspects of the approach emulates artificial tracer experiments without the burden of needing to generate signals or experimental artifacts. Tracking the effect of Gulf carbon inflow on pelagic production that appears to vary between years will be used to resolve the question of how oceanographic process affect fisheries recruitment. Finally, the value of the Ecopath modeling effort funded as restoration tool would be greatly enhanced through a incorporation of a proven model validation concept.

C. Location

Prince William Sound

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Community involvement and traditional ecological knowledge was incorporated into the sampling. For example, local fishermen provide the P.I. with the knowledge and opportunity to acquire the *Mytilus californianus* samples.

PROJECT DESIGN

Natural stable isotope abundances reflect (1) trophic level and (2) source of assimilated matter and are thus a proxy for the change in diet. Stable isotope ratios will thus be used as a indicator of production and shifts in predation as tests of hypotheses which are stated below in relation to the stated needs.

A. Hypothesis-based Objectives

The needs described above suggest several hypotheses, listed below, that form the basis for the project objectives.

For Need #1 -- thus Objective #1
$Ho_{1.1}$: The isotopic shift seen in 1995 was a singular anomaly, therefore the GOA $^{13}C/^{12}C$ values in earlier years will be consistent.
$Ha_{1.1}$: If they are different, what is the pattern (if there is one)?
$Ho_{1.2}$: The $^{13}C/^{12}C$ of *Mytilus californianus* = $^{13}C/^{12}C$ of *Neocalanus*. This is expected since both are herbivores.
$Ha_{1.2}$: If they are not equal is the there a systematic difference?

There are three goals to be fulfilled for Objective #2:

1. Reconstruct a $^{13}C/^{12}C$ time-series covering at least the 1989 - 1997 period.

2. Compare the time-series with observed $^{13}C/^{12}C$ changes in 1994-1997 (Fig. 2 plus the additional data-year (1997) currently being generated in project 311).

3. Publication of the results in the open literature.

For Need #2 -- thus Objective #2
$Ho_{2.1}$: Trophic level of each functional group predicted by Ecopath = the trophic level of each functional group predicted by their mean $^{15}N/^{14}N$.
$Ho_{2.2}$: Omnivory index of each functional group predicted by Ecopath = the standard deviation of trophic level of each functional group predicted by individual $^{15}N/^{14}N$ values.

There are three goals to be fulfilled for Objective #2:

1. Provide a better representation of the Ecopath functional groups so as to enhance model validation. Note that only a limited number of functional groups were used in the preliminary model validation (Fig. 3). The goal is to make a substantial improvement.

2. Provide validation data for the more model-sensitive higher trophic levels (D. Pauly, pers. comm.). Much of the predictive power of the Ecopath model is for trophic level 4 and 5 functional groups, therefore validation of these functional groups would provide a robust test of the model.

3. Publication of the PWS Ecopath model validation in the open literature, this would have to be a significant leap over Kline and Pauly (1998) to pass the reviewers, hence goals 1 and 2.

See Kline and Pauly 1998 (embedded within Kline 1998b) for a description of the validation method.

Data Gaps

The proposed study will build upon the existing data base; adding new data will fill data gaps and further the construction and tests of conceptual food webs supporting productivity in the greater Prince William Sound area. The goal is to determine the trophic positions and to define the natural history parameters accessible from NSI data in light of the observed declines in their populations. These include changes in trophic level over the lives of pelagic organisms, habitat dependencies, seasonal energetics and trophic dynamics relative to other community organisms. As part of this goal, we will integrate our analytical work with the field and laboratory studies of other investigators looking at food web structure, productivity of lower trophic levels, and provide validation data for assessment of conceptual and quantitative models.

Sampling objectives are listed in relation to needs and their hypotheses. The emphasis will shift among the objectives by fiscal year (these are given proceeding each objective).

B. Objective-based Methods

For Objective 1, Retrospective Analysis Of GOA Production Shifts Since EVOS

FY99-00: Stable isotopic analysis of the outer protein layer (periostracum) on the shells and body tissues of Sea-mussels (*Mytilus californianus*) of varying ages collected at Middleton Island (N= 50 mussels) in September 1997. The periostracum will be analyzed by cutting sections (of 2.0 mg for each analysis) along annular growth rings. Mussels of

different age will be used to extract data from various years (as annuli are wider and more distinct at earlier ages) to reconstruct an isotopic time series retracing conditions from 1997 backwards in time to EVOS and earlier. For example a 5 to 10 - year old mussel will resolve well recent years whereas a 10 to-20 year old will resolve years when the mussel was younger. Overlapping years (of periostracum samples) of good age resolution will be used to inter-calibrate mussels while younger mussels will be calibrated against our zooplankton database (Fig. 2). An estimated 250 isotopic analyses (~ n = 10/ mussel) will be required for this task in FY99 (*reduced from 500 in original DPD*). The expected results would consist of an isotopic characterization in GOA isotopic signature from 1989 (possibly earlier) to 1997. The following question will be asked: Did changes of the magnitude seen in 1996 occur in other years? If so, how often. If not, then the 1996 will be considered an anomaly rather than a common occurrence.

For Objective 2, Addressing Ecopath Model Validation Data Gaps

FY 99-00: A) Analysis of available samples from the P.I.'s archives and samples from other P.I.'s.

The purpose of this objective is to acquire data most cost-effectively - without additional field sampling. Functional groups identified for additional analyses are noted by the underlined yes in Table 1. Those underlined in the column "sample availability" are planned for analysis in FY99. Since the Ecopath model is centered on data collected from 1994-6 and for which years these samples are from, they are optimal for this purpose. An estimated 550 isotopic analyses will be required for this task in FY99 (*reduced from 750 in original DPD*).

FY00-01 B) Collection and analysis of additional samples as needed.
Once sample archive sources are exhausted, additional selective sampling will be made. The degree of need for additional sampling is presently unknown thus increasing uncertainty in the FY00 budget: Those functional groups with yes underlined in Table 1 under the column "sample accessibility" are expected to require this supplemental sampling in FY00. An estimated 600 isotopic analyses will be required for this task in FY00.

The methods for calculating trophic level and omnivory index are given in Kline and Pauly 1998 (also embedded within Kline 1998b). The data generated will used in a similar way.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

N/A

SCHEDULE

A. MEASURABLE PROJECT TASKS for FY99 (October 1, 1998 - September 30, 1999)

5 Oct. 1998:	Participate in Ecopath workshop
Oct. 1998 - Apr. 99:	Preparation of archived samples (for Objectives 1 & 2) for mass spectrometry
Jan - Oct 1999:	Mass spectrometry at UAF (~ 6-9 month processing time)
Jun - Oct 1999:	Process new isotope data (bulk of data expected in early FY00)

B. Project Milestones and Endpoints

Oct, 1998 - Dec 1999:	Preparation of archived samples for mass spectrometry
Jan-July 1999:	Preparation of new samples for mass spectrometry
Mar 1999, Jan 2000, 2001:	Attend Annual Restoration Workshop
Oct, 1999 - Sept 2000:	Process new isotope data
Oct, 1999 - Sept 2000;	Data, receipt (from mass spect lab), integration and synthesis
Oct, 1999 - Jan 2001:	Preparation for and dissemination of results at EVOS and other Symposia
Jan-April 1999,2000:	Preparation of Annual Reports
Jan-April 2001:	Draft final report preparation
September 2001:	Final Report revisions, completion of publications for open literature

C. Completion Date

September 2001 (Final Report)

PUBLICATIONS AND REPORTS

Kline and Pauly - a greatly augmented sequel to Kline and Pauly (1998) incorporating validation of the model developed in project 330) but is planned for FY00-01.

Kline - A paper based on the retrospective analysis is planned for FY00.

PROFESSIONAL CONFERENCES

Travel is requested for the P.I. to present results at a national (or when appropriate, international) meeting such as ASLO or AGU and to attend workshops with collaborators. Travel to present project results at national meetings and to participate in collaborative workshops are essential to the project's success.

NORMAL AGENCY MANAGEMENT

N/A

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Collaboration with other EVOS investigators will continue and facilitate relating carbon-source dependency with e.g., somatic energy content (A.J. Paul) and trophic level (D. Pauly and S. Pimm). Other P.I.'s in possession of NSI data for certain functional groups, noted in Table 1 (their names proceeded by "see") will be asked to provide appropriate portions of pertinent data for incorporation into objective #2. Results of analyses will be exchanged at workshops and by telecommunications. Preliminary analysis from the integrated effort will be used to direct retrospective analysis of archived samples. Sampling will be coordinated with other P.I.'s and within the auspices of other biota sampling programs. Pertinent data of each sample (i.e. data on each individual fish will be shared among components). Coordination in relation to specific objectives listed in project design section.

PROPOSED PRINCIPAL INVESTIGATOR

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Revised 1-6-98
Approved TC 12-15-98

FY 99 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$0.0
Travel		$0.0
Contractual		$116.8
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$116.8
General Administration		$8.2
Project Total	$0.0	$125.0
Full-time Equivalents (FTE)		11.5
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
	$143.6	$114.6	$0.0		

Dollar amounts are shown in thousands of dollars.

Comments:

FY 99

Prepared:

Project Number:99393
Project Title: Prince William Sound Food Webs: Structure and Change, Submiited Under the BAA
Name: Prince William Sound Science Center
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 99 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999						
Personnel		$64.1						
Travel		$4.3						
Contractual		$24.3						
Commodities		$2.1						
Equipment		$2.5	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$97.3		Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
Indirect		$19.5						
Project Total	$0.0	$116.8		$143.6	$114.6	$0.0		
Full-time Equivalents (FTE)		11.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:
Admin Costs not reflected in long range estimates

FY 99

Prepared:

Project Number:99393
Project Title: Prince William Sound Food Webs: Structure and Change, Submiited Under the BAA
Name: Prince William Sound Science Center
Agency: NOAA

FORM 4A
Non-Trustee
SUMMARY

FY 99 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 1999
	T. Kline	P.I.	4.5	7.9		35.6
	J. Williams	Biologist	4.0	4.5		18.0
	B. Dodge	Technician	3.0	3.5		10.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	11.5	15.9	0.0	
					Personnel Total	$64.1

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 1999
	1 national meeting	0.8	1	7	0.1	1.5
	3 workshops	0.2	3	9	0.1	1.5
	meeting registraion	0.3	1			0.3
	car rentals (total all travel)	0.1	10			1.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$4.3

FY 99

Prepared:

Project Number:99393
Project Title: Prince William Sound Food Webs: Structure and Change, Submiited Under the BAA
Name: Prince William Sound Science Center
Agency: NOAA

FORM 4B
Personnel
& Travel
DETAIL

FY 99 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Contractual Costs:	Proposed
Description	FY 1999
Stable isotope analyses (800)	20.0
Laboratory equipment use fee (800)	2.4
Photocopying	0.2
Shipping	0.3
Communications	0.4
PWSSC network charge	1.0
Contractual Total	$24.3

Commodities Costs:	Proposed
Description	FY 1999
Lab supplies miscl	0.4
Vials, chemicals, grinder blades, scalpels	0.6
Office supplies miscl.	0.4
Computer supplies and upgrades	0.5
Dyesub material	0.2
Commodities Total	$2.1

FY 99

Prepared:

Project Number:99393
Project Title: Prince William Sound Food Webs: Structure and Change, Submiited Under the BAA
Name: Prince William Sound Science Center
Agency: NOAA

FORM 4B
Contractual & Commodities DETAIL

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

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 1999
1 mg prec. elec. lab. balance (needed for making sample size aliquotes)	1	2.5	2.5
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$2.5

Existing Equipment Usage:	Number
Description	of Units

FY 99

Prepared:

Project Number:99393
Project Title: Prince William Sound Food Webs: Structure and Change, Submiited Under the BAA
Name: Prince William Sound Science Center
Agency: NOAA

FORM 4B
Equipment
DETAIL

Revision 11-3-98
Approved TC 12-15-98

ASSESSMENT OF SPOT SHRIMP ABUNDANCE IN PRINCE WILLIAM SOUND A DECADE AFTER THE EXXON VALDEZ OIL SPILL

Project Number:	99401
Restoration Category:	General Restoration
Proposer:	NOAA
Lead Trustee Agency:	NOAA
Cooperating Agencies:	Valdez Native Tribe/Charlie Hughey Prince William Sound Economic Development Council
Alaska Sea Life Center:	no
Duration:	4 year project
Cost FY 99:	$38,300
Cost FY 00:	$89,800
Cost FY 01:	$95,000
Cost FY 02:	$33,000
Geographic Area:	Prince William Sound
Injured Resource/Service:	Spot Shrimp/Subsistence

ABSTRACT

The project proposed here will estimate the abundance of spot shrimp and determine the structure of the spot shrimp population in western Prince William Sound (PWS). The project will augment current Alaska Department of Fish and Game (ADF&G) surveys to determine whether the spot shrimp population is recovering from depletion. To maintain consistency with the timing of the ADF&G surveys the first full sampling cruise will take place in October 1999. In year one we will survey western PWS for study sites. In years two and three we will estimate spot shrimp relative abundance, population structure and reproductive potential at the study sites. An added objective in year three will be an estimate of recruitment potential achieved by expanding the depth range of the sampling into shallow water to assess the relative abundance of juveniles. In year four we will close out, produce manuscripts, and provide input into the development of a shrimp management plan with ADF&G.

A. INTRODUCTION

Most crustacean stocks in Alaska are in need of rebuilding. Evidence that the rapid expansion of crab and shrimp fisheries in Alaska from 1960 to 1980 resulted in the serial depletion of these stocks is compelling (Orensanz et al. 1998). The effects on recruitment of climatic change, including climate-mediated increases in predation or disease, as opposed to overfishing, probably played an important role in the decline of many crustacean stocks in Alaska (Orensanz et al. 1998). The case for overfishing as the main cause for population decline is perhaps strongest for spot shrimp, *Pandalus platyceros* Brandt, in Prince William Sound (Trowbridge 1994, Orensanz et al. 1998).

The commercial spot shrimp fishery in Prince William Sound (PWS) began in the 1950's and remained small until the late 1970's. After 1975 the fishery expanded rapidly. The harvest increased from 7 tonnes in 1978 to more than 131 tonnes in 1986 as the number of vessels participating in the fishery increased ninefold to 80 vessels (Trowbridge 1994). Area closures after the *Exxon Valdez* oil spill resulted in a precipitous decline in the harvest in 1989. Low stock abundance necessitated closure of the fishery in 1990 by emergency order (Orensanz et al. 1998). A reduced fishery involving 15 vessels took place in the fall of 1991, but the season was closed early when a reduced guideline harvest level was reached. Catch per unit effort (CPUE) averaged 0.4 kg of whole shrimp per pot during the 1991 season. The fishery was closed in 1992 and remains closed (Trowbridge 1994, Orensanz et al. 1998). The decision point for reopening the fishery has been set tentatively at a survey CPUE of 0.6 kg (Trowbridge 1994).

Annual surveys of the abundance of spot shrimp in PWS begun in 1989 by the Alaska Department of Fish and Game (ADF&G) continue to the present. The surveys sample spot shrimp at six to eight sites in the seven major statistical reporting areas that divide the Traditional Harvest Area in western PWS (Trowbridge 1992, 1994). From 1989 to 1993 the survey CPUE has declined from 0.6 kg to 0.2 kg. During the same period the percentage of large shrimp (females) increased from 4 to 20% indicating a somewhat reduced recruitment in the near term after 1993 (Trowbridge 1994). The study proposed here would augment the ADF&G sampling program by adding population information from other areas in PWS, would enhance our understanding of spot shrimp population dynamics by providing information on juvenile distribution, abundance, and size structure, and ultimately aid ADF&G in developing a management plan for spot shrimp when the population recovers. In FY=99 NMFS personnel will consult with Valdez Native Tribe shrimpers and ADF&G to identify potential sampling sites. A preliminary, exploratory cruise in spring/summer 1999 will be conducted to evaluate these sites for the study of spot shrimp population size and structure. The first major cruise of the study will take place in October 1999 to be consistent with the seasonal timing of past ADF&G surveys. The second full year of the study (FY=01) will, in addition to estimating spot shrimp relative abundance, population structure and reproductive potential, determine recruitment potential of the spot shrimp population by expanding the depth range of the sampling into shallow water to assess the relative abundance of juveniles in the population.

NEED FOR PROJECT

A. Statement of Problem

Evidence for depletion of the spot shrimp resource in PWS after 1989 is convincing (Trowbridge 1994). The role that the *Exxon Valdez* oil spill (EVOS) may have played in the reduction of spot shrimp abundance in western Prince William Sound is unclear. Trowbridge (1992) found reduced CPUE in weight and number of spot shrimp in oiled vs unoiled areas in 1989 and 1990 in PWS. The differences in CPUE (number and weight of shrimp) did not persist into 1991. Mean size of shrimp was reduced in the oiled area in all three years. However, Trowbridge (1992) could not find conclusive evidence Athat spot shrimp within PWS were themselves affected by the EVOS@ owing, in large part to limitations in time and funding for spot shrimp damage assessment. Spot shrimp were not considered a high priority species by the EVOS damage assessment process. Lack of pre-spill abundance information coupled with confounding reductions in spot shrimp abundance prior to the spill rendered the species less favorable for a definitive damage assessment study. Trowbridge (1992) ultimately concluded that the observed abundance and structure of the spot shrimp stock in PWS in the first few years after the *Exxon Valdez* oil spill could mostly be explained by fishing pressure. Nevertheless, he hypothesized that highly sensitive shrimp larvae which were probably in the water column and near the surface during the oil spill were adversely affected by oil toxicity. No damage assessment study focused on larvae was initiated after the spill. The impact on the shrimp population after 1989 of exposure to oil of the 1989 year class in the larval stage is unknown.

Of additional concern is the increased pressure on the spot shrimp resource by sport and subsistence shrimpers as a result of greater access to western PWS following the soon to be completed access road connecting Portage and Whittier. Increased cruise ship traffic in and independent tourist visitations to western PWS in recent years may be having adverse impacts on spot shrimp habitat within PWS.

B. Rationale/Link to Restoration

This project falls under the category of monitoring. We will seek to assess the extent to which spot shrimp abundance has recovered since the population decline which began just prior to 1989. Although the major cause of the decline was probably overfishing rather than the EVOS, there is great interest by subsistence users of shrimp as well as sport shrimpers and individuals who fished for shrimp commercially in PWS prior to 1992 in the present status of the spot shrimp population in PWS. The ADF&G currently surveys spot shrimp abundance at selected locations in PWS annually. The intent under this proposal is first to broaden the geographical coverage and increase the amount of replication within existing major statistical reporting areas of the asssessment of spot shrimp abundance in western PWS. Second by focusing on the reproductive potential of females and recruitment potential as indicated by the abundance of juveniles in the population we can determine whether the population is recovering. The results of this work should greatly enhance the information base underpinning ADF&G management decisions.

C. Location

The proposed project will focus on various sites in the Traditional Harvest Area for spot shrimp in western Prince William Sound. The project will include sites currently surveyed by ADF&G as well as additional sites in statistical reporting areas currently surveyed and in adjacent reporting areas. Elements of the communities of Whittier, Valdez and Cordova that are now or have in the past been associated with the sport, subsistence or commercial harvest of spot shrimp may be affected by the results of the project.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Charles Hughey of Valdez Native Tribe will act as community facilitator for the project and will act as facilitator with villages in Prince William Sound. Shrimpers in the Valdez Native Tribe will participate in the project, providing vessels, crew, shrimp pots, buoys, line, etc.

PROJECT DESIGN

Two important considerations enter into the project design. First, the project will overlap as much as possible the existing survey sites of ADF&G as well as add sites, and, to the extent possible, the project will duplicate the methods that ADF&G uses in their surveys. This will accomplish two ends: 1) It will allow us to compare with greater confidence our data with that previously collected by ADF&G on spot shrimp abundance in western PWS in order to determine, more convincingly, whether spot shrimp population recovery is taking place in PWS, and 2) It will be more likely to provide data of the greatest use to ADF&G for future management of the spot shrimp resource in PWS.

The second consideration is that to maximize community involvement and to make the best use of traditional ecological knowledge, shrimpers associated with the Valdez Native Tribe will participate in the project. The shrimpers will, to the extent that they desire, have input into the selection of additional sampling sites and will participate in the sampling. Because the shrimp pots and other fishing equipment used by these shrimpers may differ in configuration from that used by ADF&G, the extent to which the project can overlap the ADF&G sites and sampling dates may permit the calculation of correction factors for comparison of the project=s data with that of ADF&G.

A. Objectives

1. Estimate abundance (CPUE) of spot shrimp by weight and number of individuals (years two and three).

2. Determine the sex and size composition of spot shrimp at the study sites (years two and three).

3. Estimate spot shrimp fecundity and relative number of egg-bearing females at the study sites (years two and three).

4. Estimate juvenile abundance and compare between sites (year three).

5. Compare abundance, sex and size composition, fecundity and proportion of ovigerous females between sites and years (year three).

6. Compare abundance data and data on population structure obtained under the present project with historical data collected by ADF&G to determine if the population is recovering and to assess the potential for full recovery of the spot shrimp population in PWS (year four).

7. Work with ADF&G, using data collected from this study, to develop a spot shrimp management plan for PWS.

B. Methods

The methods that will be used in the proposed study are modified after Trowbridge (1992, 1994). Shrimp pots will be fished at six sites in northern and western PWS previously surveyed by ADF&G (Figure 1). The sampling sites will be located in Unakwik Inlet, at Golden in Port Wells, in lower Culross Passage, in Herring Bay, at northeast Chenega Island and at northern Green Island. Six additional sites, yet to be determined, will be added to the existing ADF&G sites.

At least two strings of shrimp pots will be set at each site. Each string will consist of 11 pots spaced 18.3 m (60 ft) apart along a groundline and buoyed at both ends. Rectangular pots measuring 41 cm x 41 cm x 91 cm (16 in x16 in x 36 in) will be used. Pots will be covered with black woven plastic fabric (engineers cloth) except in the two opposing tunnel ends which will have a 6.4 cm (2.5 in) tunnel opening set 18 cm (7 in) into each end of the pot. The tunnels will be enclosed by 1.3 cm (0.5 in) stretched mesh web. A single 2.4 L perforated plastic jar containing chopped herring will be placed in each pot at the time of deployment. The pots will be fished in the depth range 37-146 m (20-80 fm) for a minimum of 18 h at each site. In year two additional pot sets will be made in the depth range 0-37 m (0-20 fm) to assess the abundance of juvenile spot shrimp.

Upon retrieval of the pot strings all pandalid shrimp in each pot will be speciated. Spot shrimp will be counted and weighed to the nearest gram on an electronic balance. If time permits, other species of pandalid shrimp (eg. *P. eous* and *P. hypsinotus*) will be counted and weighed. All non-shrimp bycatch will be speciated and counted. All spot shrimp will be sexed and the length of the carapace measured. Additional observations of ovigerous spot shrimp will include egg condition (eyed vs uneyed) and egg color. The egg clutches of a total of 30 ovigerous females will be sampled at each site for estimates of fecundity and the number of dead eggs in the clutch. For nonovigerous females, the presence or absence of breeding dress [characterized by "...the presence of long, simple, and plumose setae on the protopodites of pleopods" (Butler 1980)] will

be recorded. Breeding dress indicates a mature female.

A preliminary sampling cruise will be conducted in spring/summer 1999 to explore for sites to be added to those currently sampled by ADF&G. Field cruises in the two main years of sampling will be conducted in October (the time of year when ADF&G normally samples) for the purposes of comparing the catch data collected by this project with that previously collected by ADF&G.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

This project will be a partnership between the National Marine Fisheries Service, the Valdez Native Tribe with Charlie Hughey as facilitator and Prince William Sound Economic Development Council.

SCHEDULE

A. Measurable Project Tasks for FY99 (October 1, 1998-September 30, 1999)

January 1 - March 30	Consult with Valdez Native Tribe shrimpers and ADF&G.
April 1-30	Arrange logistics (vessels, equipment, contracts, etc.) for preliminary sampling cruise in spring/summer 1999.
May1 - August 30	Conduct preliminary, exploratory cruise to assess new sampling sites.
September 1 - 30	Arrange logistics (vessels, equipment, contracts, etc.) for sampling cruise in October 1999.

B. Project Milestones and Endpoints

October 15, 1999	Complete sampling for spot shrimp in first full sampling year.
March 31, 2000	Complete estimates of abundance, sex and size composition, and relative number of egg-bearing females and fecundityof spot shrimp at the study sites in year one.
April 15, 2000	Submit annual report (FY00 findings)
October 15, 2000	Complete sampling for spot shrimp in second full sampling year.
February 20, 2001	Complete estimates of abundance, sex and size composition, and relative number of egg-bearing females of spot shrimp at the study sites in year two.
April 15, 2001	Submit annual report (FY01 findings)
June 15, 2001	Complete estimates of spot shrimp fecundity and juvenile abundance at the study sites in year two.
October 31, 2001	Complete comparison of spot shrimp abundance, sex and size composition, fecundity and proportion of ovigerous females

	between sites and years.
January 15, 2002	Complete comparison of the abundance data and the data on population structure obtained under the project with historical data collected by ADF&G.
April 15, 2002	Submit final report and recommendations to ADF&G for development of a PWS shrimp management plan.

C. Completion Date

September 30, 2002

PUBLICATIONS AND REPORTS

No publications or reports will be submitted in FY99. Annual reports will be submitted on 15 April in FY00 and FY01. A final report will be submitted on 15 April in FY02. It is anticipated that at least two publications will derive from this project.

PROFESSIONAL CONFERENCES

No travel funds are requested for attendance at conferences in FY99. The principal investigators from NMFS will be attending the 10th Anniversary Exxon Valdez Symposium in March 1999 under separate funding.

NORMAL AGENCY MANAGEMENT

The National Marine Fisheries Service (NMFS) does not manage shrimp resources in Alaska and has never been required by statute or regulation to survey spot shrimp populations in PWS. No project similar to the one proposed here has been conducted by NMFS in the past without funds from the Trustee Council. Spot shrimp are managed by ADF&G which conducts annual surveys in PWS to assess the status of the resource.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The Valdez Native Tribe Facilitator Charles Hughey and Prince William Sound Economic Development Council will work with NMFS scientists to successfully complete this spot shrimp project. The ADF&G will be asked to review the proposal and subsequent reports to improve their quality and to increase their relevance to management goals.

The Prince William Sound Economic Development Council has coordinated other projects for EVOS in the past. Recent projects nearing completion are the Chenega Bay Beach Clean-up and the five Oil Waste Management buildings in Valdez, Whittier, Cordova, Chenega Bay and

Tatitlek.

PROPOSED PRINCIPAL INVESTIGATORS

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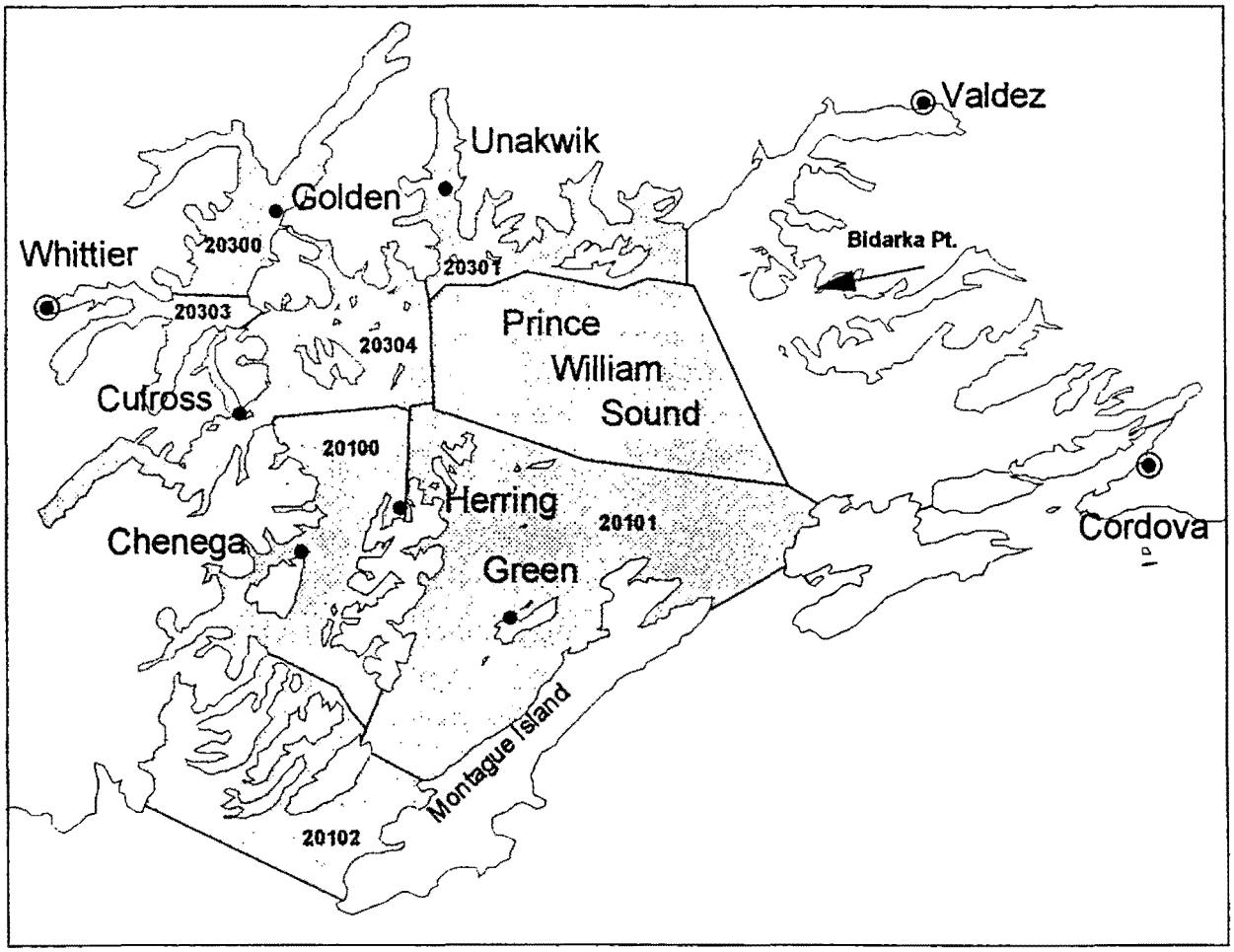

1. Proposed sampling area (shaded) and core sampling sites (closed circles) for spot shrimp abundance and population structure in western Prince William Sound. Alaska Department of Fish and Game major statistical areas for reporting commercial shellfish catch are outlined within the shaded area. (Major statistical areas are numbered). The Traditional Harvest Area is that area west of a line drawn between Bidarka Pt. and Montague Pt. (Modified after Trowbridge 1992)

Revision 11-3-98
approved TC 12-15-98

FY 99 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$12.0
Travel		$6.6
Contractual		$15.0
Commodities		$1.8
Equipment		$0.0
Subtotal	$0.0	$35.4
General Administration		$2.9
Project Total	$0.0	$38.3
Full-time Equivalents (FTE)		0.2

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
	$89.8	$95.0	$33.0		

Dollar amounts are shown in thousands of dollars.

Other Resources								

Comments:

FY 99

Prepared:

Project Number: 99401
Project Title: Spot Shrimp - A Population Dynamics Study
Agency: National Oceanic and Atmospheric Administration

FORM 3A
TRUSTEE
AGENCY
SUMMARY

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

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1999
1 Charles E. O'Clair	Marine Biologist	GS12/10	0.5	6.0		3.0
2 Mandy R. Lindeberg	Marine Biologist	GS9/2	2.0	4.5		9.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.5	10.5	0.0	
					Personnel Total	$12.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1999
JNU/VDZ/JNU	0.6	4	12	0.2	4.8
JNU/CDV/JNU	0.5	2	4	0.2	1.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$6.6

FY 99

Prepared:

Project Number: 99401
Project Title: Spot Shrimp - A Population Dynamics Study
Agency: National Oceanic and Atmospheric Administration

FORM 3B
Personnel
& Travel
DETAIL

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

Contractual Costs:	Proposed
Description	FY 1999
Vessel Charter	15.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$15.0

Commodities Costs:	Proposed
Description	FY 1999
Shrimp pots	1.8
Commodities Total	$1.8

FY 99

Prepared:

Project Number: 99401
Project Title: Spot Shrimp - A Population Dynamics Study
Agency: National Oceanic and Atmospheric Administration

FORM 3B
Contractual & Commodities DETAIL

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

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

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY 99

Prepared:

Project Number: 99401
Project Title: Spot Shrimp - A Population Dynamics Study
Agency: National Oceanic and Atmospheric Administration

FORM 3B
Equipment
DETAIL