19.08.01 (9 of 16)

Assessment of Risk Caused by Residual *Exxon Valdez* Oil in PWS, Based on P450 Activity in Fishes

Project Number:	00379
Restoration Category:	Research
Proposer:	University of Alaska Fairbanks
Lead Trustee Agency:	ADFG
Cooperating Agencies:	NMFS
Alaska SeaLife Center:	No
Duration:	2nd year, 3-year project
Cost FY 00:	$88,404
Cost FY 01	$36,801
Geographic Area:	Prince William Sound
Injured Resource/Service:	Sea otter, river otter, harlequin duck, pigeon guillemot, nearshore fishes, and subsistence resources

ABSTRACT

We propose to determine the spatial extent of potential exposure to hydrocarbons in western Prince William Sound by examining P450 activity in two coastal fishes, masked greenling (*Hexagrammos octogrammus*) and crescent gunnel (*Pholis laeta*) taken mainly adjacent to oiled mussel beds in 1998, 1999, and 2000. These fishes live and feed in the nearshore zone, and provide an index of exposure for fishes and other vertebrates. In addition, we will examine the relationships among 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 cytochrome P4501A (CYP1A) levels were noted in several intertidal fish in Prince William Sound (PWS) (Woodin and Stegeman, 1993). Elevated CYP1A, 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). The most toxic PAH may persist for years if the spilled oil accumulates in bulk reservoirs that are protected from weathering, which may subsequently be mobilized into the environment following sufficiently energetic storm events (Short et al., 1999). 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 CYPA1 have been observed as recently as 1998 in a number of higher-order vertebrates that live or feed in the nearshore environment (Holland-Bartels et al., 1998; Ballachey et al., 1999). Sea otters, river otters, Barrow's goldeneye, harlequin duck, and masked greenling all show evidence of continued exposure to hydrocarbons (see Figure 1 for examples). It is uncertain whether elevated CYP1A levels are the result of exposure to residual *Exxon Valdez* oil or other petroleum or organochlorine contaminants, 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 CYP1A in most vertebrates (e.g., sea otters or birds) because they are difficult to sample. Also, many of these animals integrate exposure from over relatively large areas, which also reduces our ability to perceive spatial patterns of exposure.

Under EVOSTC Project number 99379 two tasks were proposed for FY 99 and one task for FY 00. However, an additional task of resampling is now being proposed for FY 00 because of

elevated CYP1A levels in harlequin ducks and sea otters in 1998 (Ballachey et al., 1999; Figure 1). The two tasks currently underway are 1) an examination of the spatial distribution of potential exposure to hydrocarbons in archived coastal fishes from PWS, and 2) a determination of the relationship between CYP1A in fishes and sediment hydrocarbons collected in 1999.

FY 99 Task 1 is examining the spatial extent of exposure by measuring CYP1A 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 CYP1A induction 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 CYP1A induction in the fish from Herring Bay compared with those from Jackpot Bay (Holland-Bartels et al., 1998; Figure 2). Furthermore, spatial patterns of CYP1A in fish from Herring Bay suggest that fish from more heavily oiled parts of the bay may have higher CYP1A 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 CYP1A 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.

FY 99 Task 2 will examine the relationship between concentrations of hydrocarbons in sediments and induction of CYP1A in fishes to help determine the likelihood that elevated CYP1A levels are caused by exposure to residual *Exxon Valdez* oil. This will be accomplished mainly by comparing CYP1A in fishes adjacent to oiled mussel beds and hydrocarbons in sediments beneath the beds.

For FY 00 we propose two tasks: 1) an examination of the relationship between fish hepatic CYP1A induction and biliary fluorescent aromatic compounds (FACs) in fishes collected in 1999 and 2) resample to determine the relationship between CYP1A in fishes and sediment hydrocarbons collected in 2000.

FY 00 Task 1 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 CYP1A induction. This task will be accomplished by comparing P450s and FACs in fishes adjacent to oiled mussel beds.

FY 00 Task 2 will occur if elevated CYP1As are present in 1998 or 1999 fishes. Because laboratory results from 1998 or 1999 fishes will not be available until mid to late FY 99 continued sampling in FY 00 is proposed. If 1998 and 1999 fishes reveal no elevated CYP1A no sampling will occur in 2000 and a revised proposal for FY 00 will be submitted.

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. A critical facet of determining exposure 10 years following the spill is choosing an assay with appropriate sensitivity.

B. Rationale/Link to Restoration

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 CYP1A 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.

Also, the degree and tissue localization of CYP1A 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.

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 study are to 1) identify the spatial extent of potential hydrocarbon exposure in nearshore fishes, 2) establish associations between sediment hydrocarbon concentrations in intertidal mussel beds and CYP1A in fishes adjacent to mussel beds, 3) establish associations between values of CYP1A and FAC in masked greenling, and 4) compare the sensitivities of two CYP1A assays.

B. Methods

FY 99 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 CYP1A induction between sites with an 80% power (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 3). 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 were shipped to Dr. John Stegeman at Woods Hole Oceanographic Institution (WHOI) for CYP1A analyses in early 1999. Laboratory results were not available by mid April, 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 CYP1A 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 (IHC) assay (Goksryr 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 induction 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 induction 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 induction in different oiling categories using a one-way ANOVA.

FY 99 Task 2–Identify relationships between hydrocarbons in mussel bed sediments and CYP1As 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 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, and shipped to Dr. John Stegeman in the fall of 1999 for CYP1A analyses. Livers will be split equally with one half preserved in 5% formalin solution and the other half deep-frozen in liquid nitrogen. Bile will be collected from all masked greenling, according to the protocol established by Stehr et al. (1993). It is unlikely that sufficient bile could be collected from individual crescent gunnel. Bile will be archived and analyzed in FY 00 if CYPIA induction is observed. 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 by the IHC assay (as described for Task 1) and another assay, ethoxyresorufin O-deethylase (EROD; Stegeman and Kloepper-Sams, 1987), to compare relative assay sensitivities. Both assays will be conducted on 160 samples (10 sites x 2 species x 8 fish x 1 tissue [liver]). The approved work plan for FY 99 under Project number 99379 called for only the IHC assay to be conducted on livers. However, concerns about declining CYP1A signals as residual oil decreases led to the implementation of the additional assay, EROD, on 1999 samples at no additional cost. The EROD assay may be more sensitive for liver (J. Stegeman, Personal Communication).

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 CYP1A data.

Statistical analysis–The relationship between CYP1A levels and hydrocarbon concentrations will be examined by correlating mean CYP1A values and mean sediment hydrocarbon concentrations from each site.

FY 00 Task 1–Identify the relationship between CYP1A induction and FACs in masked greenling.

Chemical analysis–If CYPIA induction is determined in the 1999 masked greenling livers, bile of these fish will be examined for FACs. 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 CYP1As will be examined for FACs; up to 60 samples are budgeted. It is anticipated that the CYP1A results will not be available until August 1999; therefore, FAC analysis will not commence until October 1999 (FY00).

Statistical analysis–The relationship between CYP1As and FACs will be examined by correlating CYP1A values and FAC values for each site.

The proposed cost for FY 00 Task 1 is $12,800.

FY 00 Task 2– Identify the temporal relationship between hydrocarbons in mussel bed sediments and CYP1As in fishes adjacent to mussel beds.

Sampling–Repeat sampling for fish livers and sediment hydrocarbons in June 2000 will follow the protocol established in June 1999. No bile sampling will occur.

P450 analyses–Induction of CYP1A will be determined by the most sensitive assay (either IHC or EROD as described for FY 99 Task 2) in 80 greenling samples (10 sites x 8 fish x 1 tissue [liver]) and 80 gunnel samples.

Chemistry analysis–Sediment samples will be analyzed at the NMFS ABL following the protocol used in FY 99. Cost for sediment hydrocarbon analyses will be borne by ABL as in FY 99 (Project 99090).

Statistical analysis–The relationship between CYP1A levels and hydrocarbon concentrations will be examined by correlating mean CYP1A values and mean sediment hydrocarbon concentrations from each site.

The proposed cost for FY00 Task 2 is $90,992.

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 ABL and 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)

February–April:	Analyze 1998 P450 samples, arrange logistics for June cruise
June:	Collect samples
July–September:	Analyze P450 and sediment hydrocarbon samples

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

October:	Analyze biliary FAC
June:	Collect samples
July–September:	Analyze P450 and sediment hydrocarbon samples
September:	Prepare annual report

C. Measurable Project Tasks for FY 01 (October 1, 2000 – September 30, 2001)

November:	Attend SETAC meeting
April:	Submit draft final report
September:	Submit final report

D. Project Milestones and Endpoints

April 1999:	Completion of P450 analysis on 1998 samples
June:	Completion of sediment and fish collections
September:	Completion of P450 and sediment hydrocarbon analyses
November:	Completion of FAC analysis
June 2000:	Completion of sediment and fish collections
September:	Completion of P450 and sediment hydrocarbon analyses
September:	Submit annual report
November:	Present paper at SETAC meeting
April 2001:	Submit draft final report
September:	Submit final report

C. Completion Date

September 30, 2001 (FY 01)

PUBLICATIONS AND REPORTS

We cannot yet anticipate publication schedules for FY 01. 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 Nashville, TN, November 2000. 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. ABL will not be involved in sampling in 2000, however, they will analyze the sediment samples for hydrocarbons. Collaboration with NMFS ABL and 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

Stephen C. Jewett, Ph.D.
University of Alaska Fairbanks
Institute of Marine Science
School of Fisheries and Ocean Sciences
Fairbanks, AK 99775-7220
Phone: 907-474-7841
Fax: 907-474-7204
E-mail: jewett@ims.uaf.edu

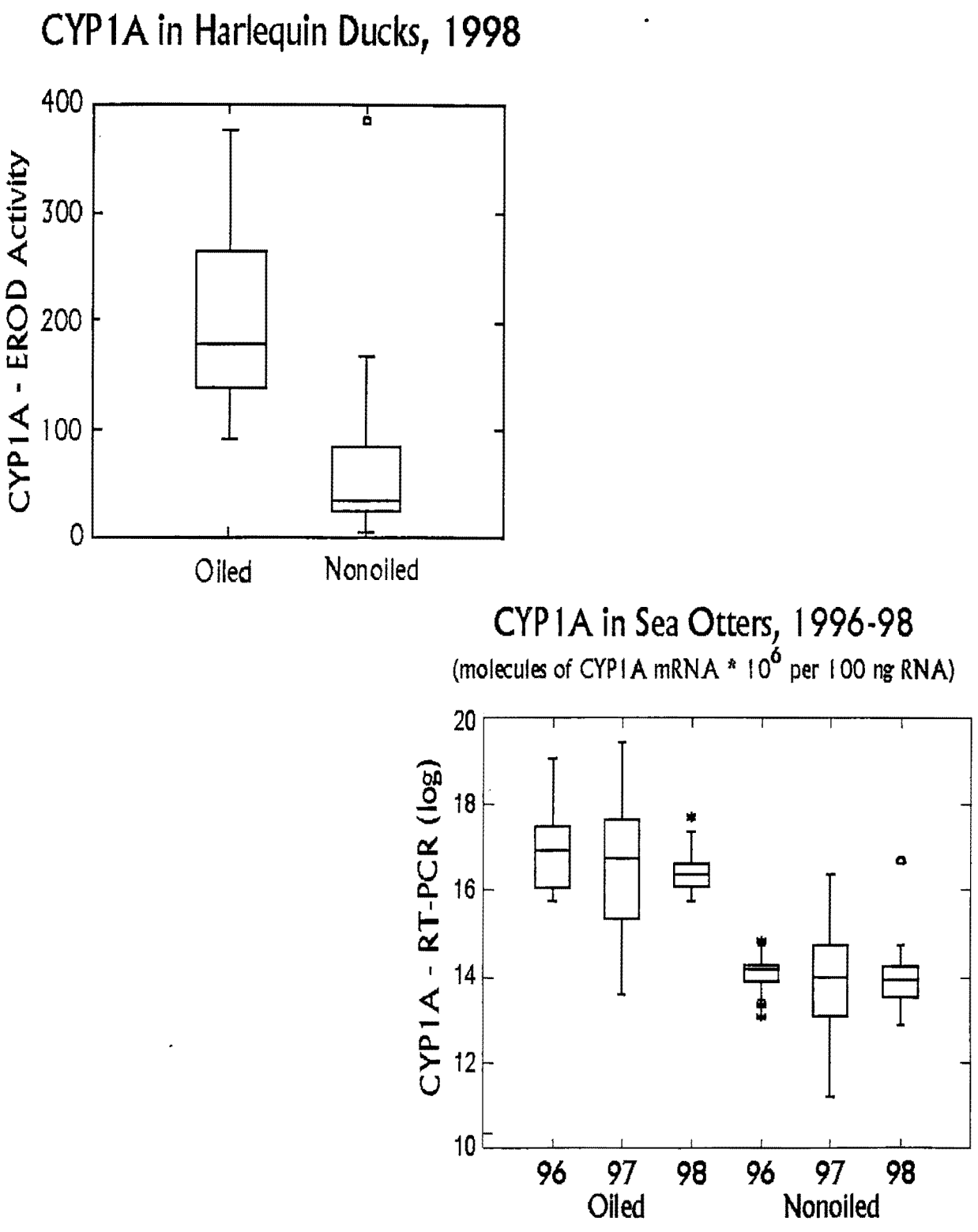


Figure 1. Box plots of recent CYP1A induction in harlequin ducks and sea otters from oiled and nonoiled areas Prince William Sound. Plots include values for median, 25th and 75th percentiles, range and outliers.

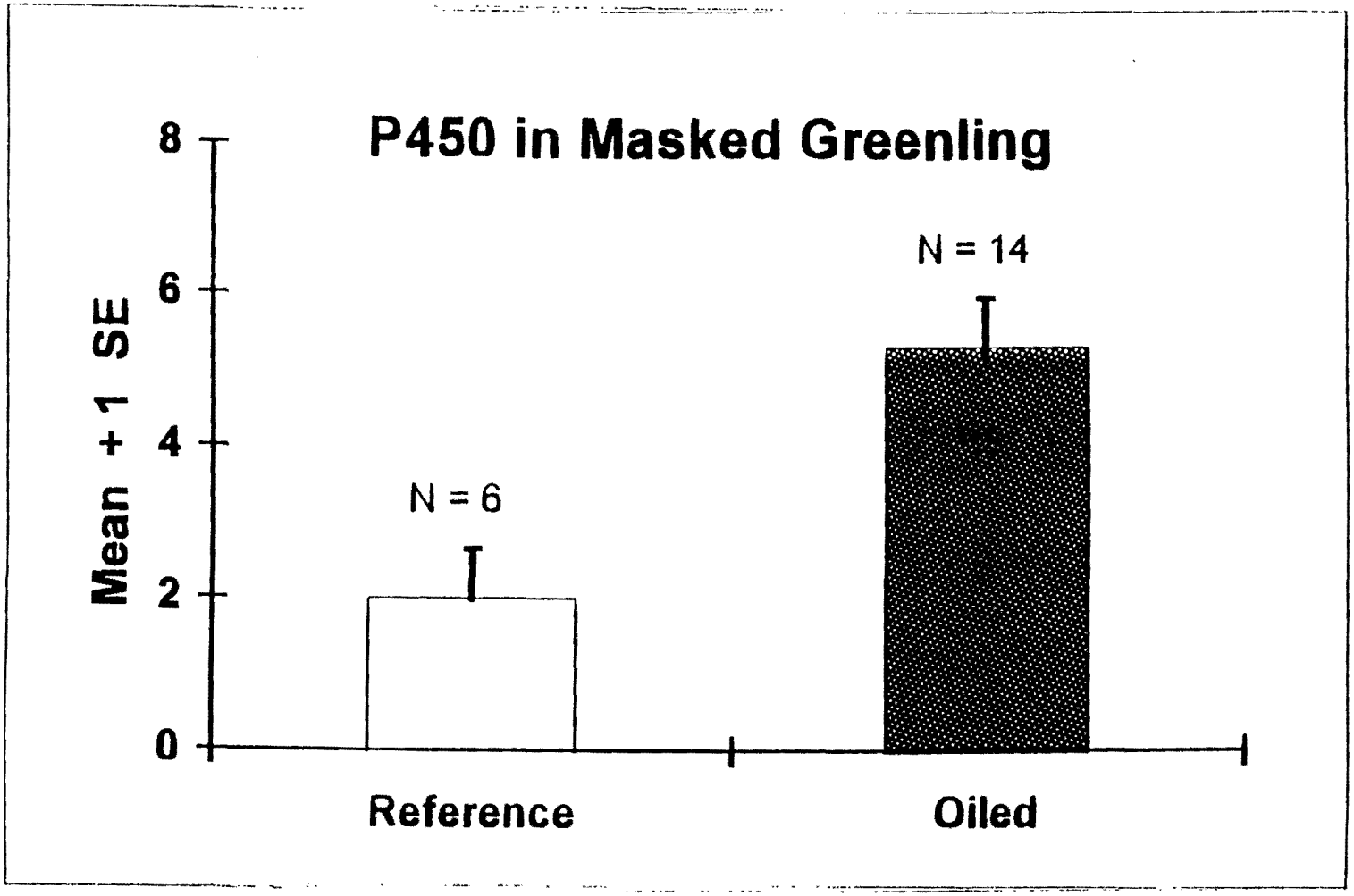


Figure 2. Comparison of cytochrome P450 (CYP1A) in masked greenling from oiled Herring Bay and unoiled (reference) Jackpot Bay, Prince William Sound, 1996.

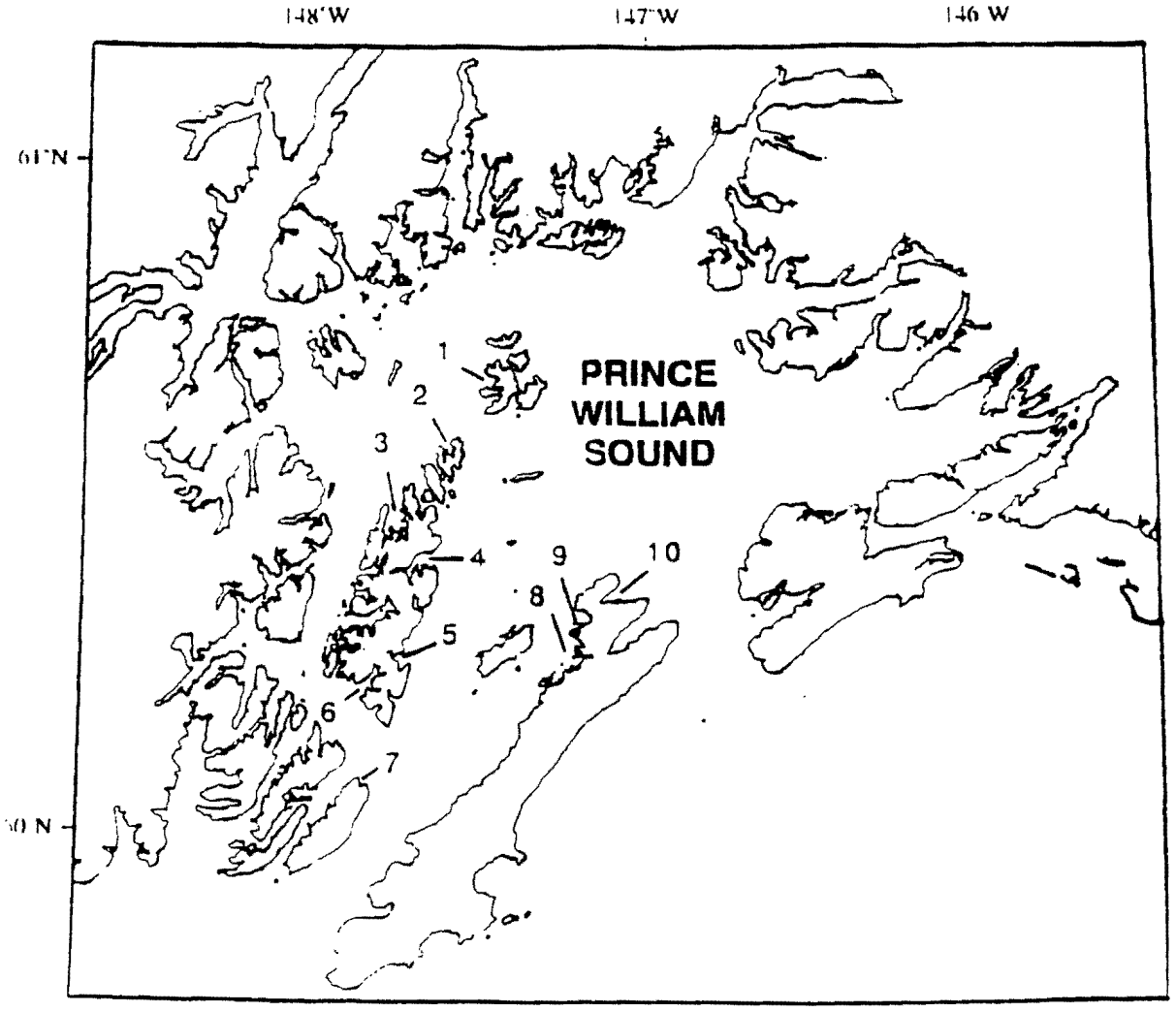


Figure 3. Fish sampling locations for P450 in 1998.
1 = Cabin Bay, 2 = Northwest Bay, 3 = Herring Bay, 4 = Bay of Isles,
5 = Snug Harbor, 6 = Mummy Bay, 7 = Sleepy Bay, 8 = Port Chalmers,
9 = Stockdale Harbor, 10 = Rocky Bay.

PRINCIPAL INVESTIGATOR

Stephen C. Jewett, Ph.D.
Dr. Jewett has been with the School of Fisheries and Ocean Science, University of Alaska Fairbanks, since 1975. He currently serves as research professor. During this time he has been involved in numerous benthic and intertidal assessment and/or monitoring investigations throughout Alaska. He has authored more than 30 publications in scientific journals and books. He has also been the coordinator of the federal/state EVOS shallow subtidal investigations in Prince William Sound (1989–1996) and an investigator on the EVOS Nearshore Vertebrate Predator research (1995–present).

OTHER KEY PERSONNEL

Thomas A. Dean, Ph.D.
Coastal Resources Associates, Inc.
1185 Park Center Drive, Suite A
Vista, CA 92083
Phone: 760-727-2004
Fax: 760-727-2207
E-mail: Coastal_Resources@compuserve.com

Dr. Dean is president of the ecological consulting firm Coastal Resources Associates, Inc. (CRA) in Vista, California. He has over 20 years of experience in the study of near-shore ecosystems, and has authored more than 20 publications, including several dealing with impacts of the *Exxon Valdez* oil spill on subtidal populations of plants and animals. Dr. Dean has extensive experience in long-term monitoring studies, and has played a major role in both intertidal and subtidal EVOS investigations since 1989.

John Stegeman, Ph.D.
Woods Hole Oceanographic Institution
Department of Biology
Redfield 3-42, MS 32
Woods Hole, MA 02543-1049
Phone: 508-457-2000
Fax: 508-457-2134
E-mail: jstegeman@whoi.edu

Dr. Stegeman is a research scientist at Woods Hole Oceanographic Institution. He is internationally recognized as an expert in the area of cytochrome P450 biomarkers of hydrocarbon exposure.

LITERATURE CITED

Anderson, J.W. and J.M. Jones. 1997. Assessment of the PAH contamination of populations of the forage fish, sand lance (Ammodytes hexapterus) inhabiting clean and oil-impacted sediments. *Exxon Valdez* Oil Spill Restoration Project Final Report. Project 96163P. 20 pp. + appendices.

Babcock, M.M., G.V. Irvine, P.M. Harris, J.A. Cusick and S.D. Rice. 1996. Persistence of oiling in mussel beds three and four years after the *Exxon Valdez* oil spill. In: Proceedings of the 1993 *Exxon Valdez* Oil Spill Symposium, Pp. 286–297. Am. Fish. Soc. Bethesda, MD.

Ballachey, B.E., J.L. Bodkin, L. Holland-Bartels, G.M. Blundell, T.R. Bowyer, T.A. Dean, S.C. Jewett, P.A. Snyder, J.J. Stegeman, and K.A. Trust. 1999. Quantification of cytochrome P450 1A as a bioindicator of exposure on nearshore vertebrate predators to residual oil from the *Exxon Valdez* oil spill. P. 99. In: Legacy of an Oil Spill 10 Years After *Exxon Valdez* (Abstracts). Anchorage, AK.

Collier, T.K., C.A. Krone, M.M. Krahn, S.E. Stein, S-L. Chan, and U. Varanasi. 1996. Petroleum exposure and associated biochemical effects in subtidal fish after the *Exxon Valdez* oil spill. Amer. Fish. Soc. Symp. 18:671–683.

Harris, P.M. and C.C. Brodersen. 1998. Monitoring of oiled mussel beds in Prince William Sound. Restoration Project 99090, funded by the *Exxon Valdez* Trustee Council for FY 99.

Goksryr, A., T. Andersson, D.R. Buhler, J.J. Stegeman, D.E. Williams, and L. Fšrlin. 1991. Immunochemical cross-reactivity of §-napthoflavone-inducible cytochrome P450 (P4501A) in liver microsomes from different fish species and rats. Fish. Physiol. Biochem. 9(1): 1–13.

Holland-Bartels et al. 1998. Mechanisms of impact and potential recovery of near-shore vertebrate predators. *Exxon Valdez* Oil Spill Restoration Project 97025. Annual Report to the *Exxon Valdez* Oil Spill Trustee Council.

Houghton, J.P., A.K. Fukuyama, D.C. Lees, H. Teas III, H.L. Cumberland, P.M. Harper, T.A. Ebert, and W.B. Driskell. 1993. Evaluation of the 1991 condition of Prince William Sound shorelines following the *Exxon Valdez* oil spill and subsequent treatment: Volume II, 1991 biological monitoring survey. NOAA Technical Memorandum NOS ORCA 67. Seattle. 201 pp.

Jewett, S.C. and T.A. Dean. 1997. The effects of the *Exxon Valdez* Oil Spill on eelgrass communities in Prince William Sound, Alaska 1990Ð1995. *Exxon Valdez* Oil Spill Restoration Project 95106. Final Report to the *Exxon Valdez* Oil Spill Trustee Council. 92 pp. + appendices.

Krahn, M.M., G.M. Ylitalo, J. Joss, and S-L. Chan. 1991. Rapid, semiquantitative screening of sediments for aromatic compounds using sonic extraction and HPLC/fluorescence analysis. Mar. Environ. Res. 31:175–196.

Krahn, M.M. and seven co-authors. 1992. Mass spectrometric determination of metabolities of aromatic compounds in bile of fish captured from Prince William Sound, Alaska, after the *Exxon Valdez* oil spill. Environ. Sci. Tech. 26:116–126.

McConnaughey, T. 1978. Ecosystems naturally labeled with carbon-13: Applications to the study of consumer food-webs. Master's Thesis, University of Alaska, Fairbanks, AK. 127 pp.

Munson, D. and C. Brodersen. 1998. Chenega shoreline restoration. *Exxon Valdez* Oil Spill Restoration Project 97291. Abstracts of 1997 Restoration Projects. *Exxon Valdez* Oil Spill Trustee Council, 1998 Restoration Workshop, January 29–30, Anchorage, AK.

O'Clair C.E., Short J.W., and S.D. Rice. 1996. Contamination of intertidal and subtidal sediments by oil from the *Exxon Valdez* in Prince William Sound. In: S.D. Rice, R.B. Spies, D.A. Wolfe, and B.A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. Am. Fish. Soc. Symp. 18:61–93.

Short, J.W., R.A. Heintz, M. Larsen, and L. Holland. 1999. The environmental persistence of PAH from the *Exxon Valdez* oil spill. P. 81. In: Legacy of an Oil Spill 10 Years After *Exxon Valdez* (Abstracts). Anchorage, AK.

Stegeman, J.J. 1989. Monooxygenase systems in marine fish. Pp. 65–92. In: C.S. Giam and L. Ray, eds. Pollutant Studies in Marine Animals. CRC Press, Boca Raton, FL.

Stegeman, J.J. and P.J. Kloepper-Sams. 1987. Cytochrome P-450 isozymes and monooxygenase activity in aquatic animals. Environmental Health Perspectives 17:87–95.

Stegeman, J.J., M. Brouwer, R.T. Di Guilio, L. Fšrlin, B.A. Fowler, B.M. Sanders, and P.A. Van Veld. 1992. Molecular responses to environmental contamination: Enzyme and protein systems as indicators of chemical exposure and effect. Pp. 235–335. In: R.J. Huggett, R.A. Kimberley, P.M. Merle, Jr., and H.L. Bergman, eds. Biomarkers: Biochemical, Physiological and Histological Markers of Anthropogenic Stress. SETAC Special Publication Series. Lewis Publishers, Chelsea, MI.

Stehr, C.M., M.S. Myers, and M.J. Willis. 1993. Collection of fish tissues for the national benthic surveillance project - necropsy procedure, tissue processing, and diagnostic procedure for histopathology. In: Sampling and Analytical Methods of the National Status and Trends Program, National Benthic Surveillance and Mussel Watch Projects, 1984–1992. Volume II. comprehensive Descriptions of Complementary Measurements. NOAA Tech. Memo. NOS ORCA 71.

Varanasi, U., T.K. Collier, C.A. Krone, M.M. Krahn, L.L. Johnson, M.S. Myers, and S-L Chan. 1995. Assessment of oil spill impacts on fishery resources: measurement of hydrocarbons and their metabolites, and their effects, in important species. *Exxon Valdez* Oil Spill State/Federal Natural Resource Damage Assessment Final Report. NRDA Project Subtidal 7. 35 pp.

Woodin, B.R., R.M. Smolowitz, and J.J. Stegeman. 1997. Induction of cytochrome P450 1A in the intertidal fish A. purpurescens by Prudhoe Bay crude oil and environmental induction in fish from Prince William Sound. Envion. Sci. and Tech. 31: 1198–1205.

Woodin, B.R. and J.J. Stegeman. 1993. Elevated P4501A protein in intertidal fish in Prince William Sound associated with the *Exxon Valdez* oil spill. Mar. Environ. Res. 35(1–2): 203–204.

2000 EXXON VALDEZ TRU E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$0.0
Travel		$0.0
Contractual		$88.4
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$88.4
General Administration		$6.2
Project Total	$0.0	$94.6
Full-time Equivalents (FTE)		0.3
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		

Dollar amounts are shown in thousands of dollars.

Comments:

FY00

Prepared:

Project Number: 00379
Project Title: Assessment of Risk Caused by Residual Exxon Valdez Oil in PWS, Based on P450 Activity in Fishes
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRL E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$21.9
Travel		$1.9
Contractual		$53.1
Commodities		$0.2
Equipment		$0.0
Subtotal	$0.0	$77.1
Indirect		$11.3
Project Total	$0.0	$88.4
Full-time Equivalents (FTE)		0.3
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		$34.4			

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.

FY00

Prepared:

Project Number: 00379
Project Title: Assessment of Risk Caused by Residual Exxon Valdez Oil in PWS, Based on P450 Activity in Fishes
Name: Stephen C. Jewett

FORM 4A
Non-Trustee
SUMMARY

2000 EXXON VALDEZ TRU E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2000
	Jewett, S.	Principal Investigator/Research Prof.	2.0	8.3		16.6
	Hoberg, M.	Technician	1.0	5.3		5.3
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	3.0	13.6	0.0	
					Personnel Total	$21.9

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2000
	R/T Fairbanks to Anchorage	0.4	2	9	0.1	1.9
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$1.9

FY00

Prepared:

Project Number: 00379
Project Title: Assessment of Risk Caused by Residual *Exxon Valdez* Oil in PWS, Based on P450 Activity in Fishes
Name: Stephen C. Jewett

FORM 4B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRL E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
Freight	0.2
Coastal Resources Associates (sampling/data analyses)	22.1
Wood Hole Oceanographic Institute (processing/interpretation of 272 P450 samples)	20.8
Boat charter	10.0
Contractual Total	$53.1

Commodities Costs:	Proposed
Description	FY 2000
Amber vials	0.2
Commodities Total	$0.2

FY00

Prepared:

Project Number: 00379
Project Title: Assessment of Risk Caused by Residual Exxon Valdez Oil in PWS, Based on P450 Activity in Fishes
Name: Stephen C. Jewett

FORM 4B
Contractual & Commodities
DETAIL

2000 EXXON VALDEZ TRI E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2000
			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	

FY00

Prepared:

Project Number: 00379
Project Title: Assessment of Risk Caused by Residual Exxon Valdez Oil in PWS, Based on P450 Activity in Fishes
Name: Stephen C. Jewett

FORM 4B
Equipment
DETAIL

Exxon Valdez Oil Spill Information-Transfer Program for Managers

Project Number:	00382
Restoration Category:	General Restoration
Proposer:	Dave Gibbons
Lead Agency:	USFS
Cooperating Agencies:	
Alaska Sea Life Center:	no
Duration:	1st year, 2-year project
Cost FY00:	$ TBD
Cost FY01:	$ TBD
Cost FY02:	$
Geographic Area:	Entire EVOS area
Injured Resource/Service:	All

ABSTRACT

Communicating the results of the EVOS restoration program has been an on-going activity for the Restoration Office. Scientists conducting restoration funded projects are encouraged to publish their results in peer reviewed literature, present their results at professional conferences and at the annual EVOS symposium. These activities are essential in coordinating and integrating restoration projects, and in making information available to the scientific community. The Trustee Council also works to communicate information to the public. One audience that has not been the focus of these efforts is the mid-level managers who make daily decisions in the management of injured resources and services throughout the oil spill area. These individuals are often informed about restoration activities conducted by their own agencies, but are often unaware of information gathered by other agencies which could benefit their management activities. This information is also important for communities, private-land and corporation land managers. This project would facilitate communication of the restoration program with managers through a number of different media tailored to the particular audience. One method will be through a workshop specifically designed for management purposes. Another method will be through the internet that contains information pertinent to managers. An interagency coordination group would evaluate the effectiveness of the workshop and home page to assure information is provided in a timely manner.

INTRODUCTION

The *Exxon Valdez* Oil Spill (EVOS) restoration effort has been greatly enhanced by the level of communication with the public that has been promoted by the Trustee Council. Considerable effort has been made through public meetings, newsletters and radio shows to inform people of the type of work being conducted, and of opportunities to participate, in the restoration program. In addition, the annual EVOS symposium facilitates the communication between the principal investigators that are conducting restoration projects throughout the oil spill area. These efforts have demonstrated the importance of communication in the restoration effort. This project is designed to increase communication between the EVOS program and the individuals who make daily decisions in the management of the oil spill area. The project would further enhance the usefulness of the restoration program by targeting mid-level managers in agencies and corporations. These managers generally have direct responsibility for the management of land and resources throughout the EVOS area.

The focus of the managers' information-transfer pilot program would be to facilitate the understanding of how the research and restoration efforts can be utilized in the daily management of the EVOS injured resources. In FY99 agency liaisons and the Restoration Office brainstormed approaches for reaching agency managers. Because there are many different approaches to providing information to managers, this program is a pilot project to disseminate information to Forest Service managers. The results of this project would be used to make recommendations for an expanded program that could reach all agencies and interested private landowners and corporation employees.

NEED FOR THE PROJECT

A. Statement of Problem

The EVOS Trustee Council has recognized the need for communication and information transfer as part of its restoration efforts. The public and the management agencies have pointed out that much of the research that is done only provides employment for scientists and has limited real-world benefit. The Trustee Council has been asked to find a method to bring all of this research to a point that it helps the injured resources and services. The Trustee Council has recognized that an important audience, the mid-level manager, has not been emphasized in the Council's efforts to distribute EVOS information. Presentations designed for mid-level managers falls between the information presented to the general public and the technical information geared towards the EVOS principal investigators. These managers are often the individuals who are responsible for making the daily management decisions that affect the resources injured by the oil spill, or affect the way people use the oil spill area. Because managers are often different individuals than those conducting research and restoration activities, it has been difficult to ensure that managers are informed about the applicability of the restoration efforts that have been undertaken. Summarizing the results of restoration efforts to managers would expand the opportunities for the information to be applied in the daily management of the EVOS area.

All of the injured resources and services are managed in some capacity by the different Trustee agencies or by Native Alaskan or private land owners. Each agency or group has different missions and responsibilities. These differences complicate the effort to identify information

that may be appropriate to each agency. Therefore, this project is proposed as a pilot project to test some of the different approaches that may be appropriate for wider audiences.

B. Rationale/Link to Restoration

During the annual EVOS symposium in 1997, a panel of managers was asked to speak about the type of information that they needed to better manage the land and resources within the spill area. One of the speakers asked for assistance in understanding how to use the newly acquired information in the daily management of the resources. This information-transfer program is a pilot project to test methods that would provide the assistance to allow managers to make informed decisions that can facilitate the restoration of all of the injured resources. Because this program will address the management of all resources and services, it would enhance the restoration of all of the resources and services in the spill area.

C. Location

The information-transfer program would be organized in Anchorage; however, the entire oil spill area would be included in the focus of the presentations and products.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Traditional ecological knowledge (TEK) has proved to be an important component in many of the restoration efforts funded by the Trustee Council. The information gathered from the communities or through the programs would also be an important component of this project. Managers should be informed about the wealth of information in our local communities and can use this information in understanding how particular management decisions may affect communities and local residents. Future application of an information-transfer program would include Alaskan Native Corporations and individuals. Therefore the long-term goal of this project would be designed to benefit communities as well as agencies.

PROJECT DESIGN

A. Objectives

1. To facilitate the ability of managers to apply the information and techniques gained in the restoration program

2. Provide the opportunity to discuss the restoration program accomplishments with managers who could apply the information in the daily management of the EVOS area

3. Evaluate the effectiveness of the proposed methods to disseminate information to managers.

B. Methods

In March 1999, a small group of Forest Service employees were asked to participate in a meeting to discuss EVOS information and its potential value to various agency positions. The group consisted of a Forest planner, recreation specialists, a special-use permit coordinator, the Forest's public information staff officer, and a State and Private Forestry ecologist. This small, informal meeting provided some valuable information to focus this pilot project. First, it became obvious that the agency biologists and ecologists should be the primary target audience since other implementation-based positions rely on recommendations from the resource specialists to identify environmental effects of specific project actions through the NEPA process. Secondly, the group emphasized that any format chosen, must be widely available and easy to use. Most of the participants favored information presented over the internet. Finally, the group identified environmental educators and librarians other potential audiences that could utilize the EVOS information in their daily jobs. The results of this meeting have been used to design this pilot project proposal.

This pilot project will incorporate several techniques to distribute information. Because the EVOS restoration program accomplishments will need to be summarized to highlight management implications, there will be two phases to this project. First, we will review the published literature and final reports to create a report that identifies results that may be important for management. There are currently 288 published articles and another 240 (approximately) final reports available for review. This information will be arranged into a topical bibliography so that a manager can easily find relevant information and can identify its source if they wish to obtain additional information. This synthesis of the information will be provided to managers in the second phase of the project.

The second phase of the project will focus on the distribution of information. The topical bibliography would be incorporated into the USGS "Internet-based digital index of research publications funded by the Exxon Valdez Oil Spill Trustee Council, 1990-present" if that project is funded by the Trustee Council. This will allow the information to be posted on the internet to provide an early tool for distributing the information more broadly. A more focused website will be considered during the workshop and would be discussed in the evaluation of this information-transfer program. A workshop for Forest Service managers will be held in Anchorage. A 1-2 day workshop will be developed to provide an overview to managers. While the primary audience for the workshop will be biologists and ecologists, other key personnel will be invited and encouraged to attend. The workshop participants will be provided with the topical bibliography, and overview sessions to allow for discussion on key topics. The specific details of this workshop will be designed after further discussion with the Restoration Office; however, the following workshop elements will be considered:

1. guest speakers could include the project leaders from the SEA; APEX and NVP projects, the Chief Scientist, and potentially some of the peer reviewers
2. agency liaisons could be asked to attend to respond to questions related to results from projects conducted by their agencies
3. workshop participants would be invited from throughout Region 10 of the Forest Service (Chugach and Tongass National Forests)
4. the target audience would be Forest Service biologists and ecologists
5. additional audiences would include environmental educators, planners and special-use permit coordinators

One session within the workshop will be dedicated to reviewing existing information sources. This will include presentations on the information that is currently available at libraries and over the internet. The final session would be dedicated to designing a format for broader distribution of the data. Participants will evaluate the topical bibliography, describe desired changes and identify new media for distributing the information. Once this pilot phase is complete, we should have a good basis for developing a program that could reach all agencies and a broad audience.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

As with the overall restoration program, it would be important to have all of the EVOS Trustee Agencies involved in this information-transfer workshop. Although the USFS would take the primary responsibility for the coordination of this program, all of the agencies would be involved in the workshop. This involvement is important both for the distribution of information to the workshop participants, and for the ability of the other Trustee agencies to evaluate the approach for application within their agencies.

The USGS Biological Resources Division will incorporate the results of the topical bibliography into its website if the project is funded by the Trustee Council.

SCHEDULE

A. Measurable Project Tasks for FY00

October - March:	Review of publications
January:	Attend EVOS conference
March – May:	Produce draft topical bibliography, begin workshop design
May:	Invite participants
May - August:	Finalize workshop design and preparation, incorporate bibliography onto USGS website
September 1-30:	Hold workshop and evaluate participants' response

FY01

October-November:	Summarize results, write final report

B. Project Milestones and Endpoints

This project has two phases: 1) evaluate literature and final reports to produce topical bibliography; 2) provide the opportunity for managers to discuss EVOS results and information sources. Both of these objectives would be met when the information-transfer workshop is completed in late September, 2000. The following milestones are identified to track the progress of the program:

FY00

March:	Potential presentations solicited from designated principal investigators
May:	Draft topical bibliography completed; workshop participants invited
August:	Topical bibliography incorporated into USGS website;

workshop design completed

September: Hold workshop

FY01

October – November: Evaluate workshop response; finalize bibliography

C. Completion Date

This project would be completed when the information-transfer workshop has been reviewed in October or November 2001.

PUBLICATIONS AND REPORTS

A topical bibliography would be distributed at the workshop. This document would be designed to remind managers of the management application of the EVOS research and restoration projects as well as to provide contacts for future coordination of management and restoration efforts.

PROFESSIONAL CONFERENCES

Not applicable.

NORMAL AGENCY MANAGEMENT

This information-transfer workshop would cover all of the EVOS area as well as have participants from each of the Trustee Agencies. Therefore, the scope of this workshop is well beyond the normal management jurisdiction of the Forest Service or any individual trustee agency. This workshop is similar to the annual EVOS symposium sponsored by the Restoration Office, except that it would be targeting a different audience.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This information-transfer program, would be designed to bring information from EVOS funded restoration projects to managers in the Forest Service. As a pilot project it will allow for a broader application that would effect all agencies. Since this project is based on existing research results it is highly integrated with the overall restoration program. In addition, the USGS has proposed the development of an Internet-based digital index of research publications. This project, if it is funded would be closely coordinated with this effort. The USGS will incorporate the topical bibliography into its proposed website. Both projects will require review of existing publications and close coordination between the projects will be necessary to reduce duplication of effort.

PROPOSED PRINCIPAL INVESTIGATOR

Karen A. Murphy
Chugach National Forest
3301 C Street Ste 300
Anchorage, AK 99503
(907) 271-2286
(907) 271-3992 (FAX)
kmurphy/r10_chugach@fs.fed.us

PRINCIPAL INVESTIGATOR

Karen A. Murphy

Karen Murphy received a Masters in Environmental Management from Duke University in 1995. Her thesis emphasis was on applying decision theory and risk assessment to wildlife management. Karen has extensive experience with fish and wildlife management on the Chugach National Forest. She began working in Alaska in 1984 as a biological technician responsible for conducting field surveys and monitoring in PWS, Copper River Delta and other areas of the Chugach National Forest. In 1991, she began working with the EVOS Restoration Planning Work Group. She participated in the development of the EVOS Restoration Plan and companion EIS. Since 1996, Karen has been the wildlife biologist for the Glacier Ranger District which covers western PWS and Turnagain Arm. Her current position, combined with her EVOS experience will enhance the opportunity to integrate this project with other EVOS projects and to apply the results to wildlife management on the Chugach National Forest. Karen will have primary responsibility for administering and coordinating this project.

OTHER KEY PERSONNEL

Unknown at this time.

Distribution of Cutthroat Trout and Dolly Varden in Western Prince William Sound

Project Number:	00383
Restoration Category:	Monitoring
Proposer:	USFS
Lead Trustee Agency:	USFS
Cooperative Agencies:	ADF&G, Chenega Corporation
Alaska Sea Life Center:	No
Duration:	1st year, 3-year project
Cost FY 00:	$28.1
Cost FY 01:	$26.0
Cost FY 02:	$5.0
Geography Area:	Western Prince William Sound
Injured Resource / Service:	Cutthroat Trout and Dolly Varden

ABSTRACT

Cutthroat trout and Dolly Varden are currently listed as a resource injured from the *Exxon Valdez* Oil Spill and their recovery is unknown. Significant gaps in knowledge exist regarding the distribution and relative abundance of these species, particularly in western Prince William Sound (PWS). Without such basic information, determining the effect of the spill or implementing prudent management techniques for recovery is very difficult. This management situation will be exacerbated as a result of increased access for anglers and others to PWS created by the road to Whittier scheduled to open in May of 2000. In this study, we will investigate watersheds that have a high likelihood of containing these species to further describe the population distributions. This project is designed to integrate with past and current research on cutthroat and Dolly Varden in PWS. The results of this study, when combined with these other findings, will provide a more complete picture of these species in PWS and will greatly assist managers in future restoration and conservation efforts.

INTRODUCTION

Both the coastal cutthroat trout, *Onchorhynchus clarki,* and the Dolly Varden *Salvelinus malma*, are known to occur in Prince William Sound (PWS; Howse 1975). The cutthroat trout found here represent the northern and western most extremes of their range in North America (Morrow 1980). Although relatively little is known in PWS, these populations are considered to be small, sensitive, few in number, and relatively isolated from one another. Dolly Varden are more common than cutthroat, but knowledge is also limited (Alaska Department of Fish and Game 1998). Both species are important ecological and recreational resources described as injured by the *Exxon Valdez* Oil Spill (EVOS) and their recovery is currently unknown (Hepler et al. 1993).

The purpose of this study is to gain an understanding of basic distribution for these two species in PWS. A larger perspective is needed to accurately define the scope of impacts and recovery relating to the oil spill. Sampling will be coordinated with EVOS project 00XXX (Growth rates of cutthroat trout and Dolly Varden in PWS: Comparison of populations in oiled and unoiled sites with similar geographic features) and possible sample sites will be prioritized to aid researchers of this study. All data collected will be integrated with results from EVOS project 97302 (Inventory of cutthroat trout and Dolly Varden in PWS) and other past efforts. Distribution information will be submitted to the Alaska Department of Fish and Game for inclusion in the Anadromous Waters Catalog. Furthermore, the results of this study will establish population baselines for the Prince William Sound human use and wildlife disturbance model (EVOS project 99339) designed to provide a management tool to protect injured, recovering and sensitive fish and wildlife populations.

NEED FOR THE PROJECT

A. Statement of Problem

Limited information is available on the distribution of both cutthroat trout and Dolly Varden within PWS, particularly within the western region. Past efforts have either focused primarily in eastern Prince William Sound where cutthroat populations are more numerous and of larger size (EVOS projects 93106 and 97302) or were conducted for anadromous fish studies (Prince William Sound Aquaculture Corporation lake studies 1982-1985; and many others). Although project 97302 did contribute significantly to knowledge of cutthroat trout and Dolly Varden in eastern PWS, sampling was not conducted in the western region. Locations of populations listed in EVOS project 97302 in western PWS were limited to past knowledge that had not yet been submitted to the ADF&G Anadromous Waters Catalog. There is strong evidence suggesting the existence of other populations within western PWS. With minimal sampling effort, four populations of cutthroat trout were found during the summer of 1994. It appears that previous surveys lacked the rigor needed to determine presence of these species. Insufficient information regarding distributions of cutthroat trout and Dolly Varden has made it difficult to determine recovery and impacts from the oil spill.

B. Rationale/Links to Restoration

In the *Exxon Valdez* Restoration Plan, the EVOS Trustee Council recommends an ecosystem approach to restoration. Ecosystem restoration can be described as the reestablishment of processes, functions, and related biological, chemical, and physical linkages between the biotic and abiotic

features. This includes the interactions between organisms with their environment as well as interactions between and among populations of the same species.

Large-scale spatial structure and dispersal mechanisms are critical to the persistence of many species (Gilpin 1987; Shaffer 1987; Hanski 1991; Hanski and Gilpin 1991; Boyce 1992; Rieman et al. 1993). Large groups of interacting populations in this context can be defined as metapopulations (Shaffer 1987; Hanski and Gilpin 1991). These groups are more likely to interact and interbreed among themselves than with other groups, but exchange of individuals occurs through different dispersal mechanisms (Rieman et al. 1993). The diversity of groups can provide stability to the metapopulation in the event of local extinctions and larger catastrophic disturbances.

Salmonids exhibit many characteristics of metapopulations. Homing and spawning fidelity create isolation among groups and represent the basis for the stock concept (Ricker 1972). Dispersal of individuals is maintained through straying of migrating adults (Simon 1972; Labell 1992), density-dependent displacement of individuals, and maintenance of colonizing phenotypes (McMahon and Tash; Northcote 1992).

Metapopulation dynamics are important considerations in conservation planning and species maintenance and recovery efforts (Murphy and Noon 1992; Noon and McKelvy 1992). By understanding the uniqueness of populations, their distribution, and degree of isolation, managers can develop more efficient and prudent conservation and recovery plans. Such information is very limited for cutthroat trout and Dolly Varden in PWS.

The results of this project will help to fill existing gaps in knowledge regarding the distribution of these species. Combining these results with other existing data (including EVOS projects 97302 and 99145), will provide managers with a better understanding of the population dynamics for cutthroat trout and Dolly Varden in PWS. Such knowledge is necessary to determine the relative impact of the oil spill and to guide managers with recovery efforts.

Further benefits would be realized by providing this distribution data to efforts of EVOS project 99339 (Prince William Sound Human Use and Wildlife Disturbance Model). With the construction of the Whittier road, the number of angler days are predicted to increase from an average of 9,800 days to 81,750 days in the year 2015 in PWS (Alaska Department of Transportation and Public Facilities 1995). Anadromous cutthroat trout are highly susceptible to over harvest (Gresswell and Harding 1997) and it is likely that they will be a highly sought after recreational resource because of limited opportunities to catch cutthroat elsewhere in north central Alaska. Hence, recovery could be hampered by over exploitation. Baseline data is needed for comparing existing and potential human use patterns with sensitive fish populations to effectively manage these species and to insure recovery.

C. Location

Distribution studies would occur in streams and lakes of western PWS. Exact sampling locations would be determined by a coarse filter analysis using variables that have strong associations with cutthroat presence elsewhere in PWS. In preliminary investigations, we found approximately 60 watersheds that have a high probability of cutthroat trout occurrence. Benefits of this project would be realized by all recreational and subsistence users of the Sound, but particularly by the residents of Whittier, Chenega, Valdez, and Tatitlek.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Native Groups, community leaders, and local interest groups would be contacted to solicit traditional and local knowledge regarding fish populations and recreational and subsistence use patterns.

PROJECT DESIGN

A. Objectives

1. Determine the distribution of cutthroat trout and Dolly Varden in streams and lakes in western PWS.

2. Coordinate with project 00XXX to provide locations of other populations and aid in collection of samples for cutthroat trout and Dolly Varden growth studies.

3. Compile the information on population locations from this project and other investigations for inclusion in the Alaska Department of Fish and Game Anadromous Waters Catalog.

4. Provide results for a risk assessment study of resident and anadromous cutthroat trout populations in PWS.

B. Methods

To locate sampling sites with high probabilities of occurrence, the Alaska Department of Fish and Game (ADF&G), Native villages and corporations, local sport groups, and other sources will be solicited for information on the location of known populations. Secondly, the Geographical Information System (GIS) will be used to query possible sample locations based on watershed area, channel type, and other variables strongly associated with presence of these species.

Presence and absence sampling for cutthroat trout and Dolly Varden will occur in lakes and streams. Lakes will be sampled using minnow traps and hook and line at a variety of depths and locations dependent on lake characteristics. Streams reaches will be stratified based on channel (USDA 1992) and macro habitat type (Hawkins et al. 1993) with approximately 20 percent of the available habitat sampled using minnow traps, hook and line, or snorkeling. Species, catch per unit effort (CPUE) and length will be recorded. Previous surveys indicate that cutthroat trout in PWS have a patchy distribution and are generally found in upper reaches with more confined channel types (Dan Gillikin and Gordon Reeves personal communications). Therefore, sampling effort will be more intense in these areas.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

This project will be implemented entirely by the U.S. Forest Service (USFS). However, the ADF&G will participate in sampling and will be asked to provide any other available data. Ken Hodges, USFS, would be contacted for information regarding EVOS project 97302 for possible sampling sites and to coordinate assimilation of all available cutthroat data for PWS. Additionally, we will

coordinate sampling with Gordon Reeves, USFS, to collect needed samples for EVOS project 00XXX and provide baseline data to Karen Murphy, USFS, for the Prince William Sound human use and wildlife disturbance model (EVOS project 99339).

SCHEDULE

A. Measurable Project Task for FY 00 (October 1, 2000 - September 30, 2000)

October 1 - March 1:	Contact ADF&G, Native groups, community leaders, and use GIS query to locate possible sampling areas.
January:	Attend annual workshop
March 1 - May 1:	Finalize sampling areas, arrange logistics and hire personnel.
May 15 - August 31:	Conduct surveys, coordinate sampling with growth-study researchers
September 1 - 30:	Compile results and write annual report.

B. Project Milestones and Endpoints

FY00

October 1 - March 1:	Contact ADF&G, Native groups, community leaders, and use GIS query to locate possible sampling areas.
March 1 - May 1:	Finalize sampling areas, arrange logistics and hire personnel.
May 15 - August 31:	Conduct surveys, coordinate sampling with growth-study researchers
September 1 - 30:	Compile results and write annual report.

FY01

October 1 – March 1:	GIS query to locate possible sampling areas.
April 15:	Submit annual report for FY00
March 1 - May 1:	Finalize sampling areas, arrange logistics and hire personnel.
May 15 - August 31:	Conduct surveys, coordinate sampling with growth-study researchers
September 1 - 30:	Compile results

FY02

April 15:	Submit annual report for FY01
October 1 – Sept. 30:	Compile results and write final report. Send update to Alaska Department of Fish and Game for inclusion in the Anadromous Waters Catalog and provide results for the risk assessment study.

C. Completion Date

The final report summarizing the project results will be provided for peer review in the year 2002.

PUBLICATIONS AND REPORTS

No professional publications are planned for the final report at this time. However, the final report and all data will be made available to other researchers and managers to aid in the development of a more ecologically based management plan.

PROFESSIONAL CONFERENCES

At this time there are no plans to present this project at professional conferences. However, a poster board display is planned in 2002 Restoration Workshop and for presentations on the Chugach National Forest.

NORMAL AGENCY MANAGEMENT

Although such information can greatly aid in management decisions, general distribution surveys for fish and wildlife populations are not mandated by statute or regulation as responsibilities of the USDA Forest Service.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This study was designed to integrate with other EVOS research on the distribution of cutthroat trout and Dolly Varden, the relationship between populations, and their sensitivity to human impacts. We will be cooperating with USFS with other research efforts on cutthroat trout and Dolly Varden in PWS. This includes providing samples and population locations for EVOS project 00XXX as well as coordinating with researchers responsible for the inventory of these species in eastern PWS (EVOS project 97302). Data from this project will also provide baseline information for the PWS human use and wildlife disturbance model (EVOS project 99339) and for a risk assessment of cutthroat trout populations in PWS.

PROPOSED PRINCIPAL INVESTIGATOR

Robert Spangler
U.S. Forest Service
P.O. Box 129
Girdwood, AK 99587
(907) 783-3242
FAX: (907) 783-2094

PRINCIPAL INVESTIGATOR

Robert Spangler is a fisheries biologist with the U. S. Forest Service, Glacier Ranger District, Chugach National Forest. He obtained his B. S. degree in Fisheries from Oregon State University and a M. S. Degree in Fisheries Science from the University of Idaho. He has worked primarily with cold water fishes of the western U. S. and has a total of ten years of fisheries experience in Oregon, Idaho, Montana, and more recently, Alaska. Relevant investigations include distribution, abundance, and seasonal habitat utilization of westslope cutthroat trout, *O. clarki lewisi*, and bull char, *S. confluentus*, as well as distribution and habitat studies of chinook salmon, *O. tshawytscha*, steelhead, *O. mykiss*, and the interior redband trout, *O. mykiss gairdneri,* in Montana and Idaho.

OTHER KEY PERSONNEL

Dan Gillikin is a fisheries technician with the U. S. Forest Service, Glacier Ranger District, Chugach National Forest. He has eight years of experience with Private and Federal Agencies in Washington and Alaska and has spent six years working with Dolly Varden and cutthroat trout in PWS. His responsibilities include GIS modeling and the logistical aspects of project implementation.

LITERATURE CITED

Alaska Department of Fish and Game. 1998. Catalog of waters important for spawning, rearing or migration of anadromous fishes. South Central Region, Resource Management Region II. Juneau.

Alaska Department of Transportation and Public Facilities 1995. Whittier access project, revised draft Environmental Impact Statement and revised draft Section 4(f) Evaluation, May 1995. FHWA-AK-EIS-94-02-DR.

Boyce, M. S. 1992. Population viability analysis. Annual Review of Ecology and Systematics 23:481-506.

Gresswell, R. E. and R. D. Harding 1997. The role of special angling regulations in management of coastal cutthroat trout. Pages 151-156 *in* J. D. Hall, P. A. Bisson, and R. E. Gresswell, editors. Sea-run cutthroat trout: biology, management, and future conservation. Oregon Chapter, American Fisheries Society.

Gilpin, M. E. 1987. Spatial structure and population vulnerability. Pages 125-139 *in* M. Soule, editor: Viable populations for conservation. Cambridge University Press, New York, New York, USA.

Hanski, I. 1991. Single species metapopulation dynamics: concepts, models, and observations. Biological Journal of the Linnean Society 42: 17-38.

Hanski, I., and M. E. Gilpin 1991. Metapopulation dynamics: brief history and conceptual domain. Biological Journal of the Linnean Society 42: 3-16.

Hawkins, C. P., and 10 others. 1993. A hierarchical approach to classifying stream habitat features. Fisheries 18: 3-12.

Hepler, K., PA Hansen, D. R. Bernard, 1993. Impact of Oil Spilled from the *Exxon Valdez* on Survival and Growth of Dolly Varden and Cutthroat Trout in Prince William Sound, Alaska. Alaska Department of Fish and Game, 32 pages.

Howse, N. R. 1975. Upper Prince William Sound wildlife and fisheries resource inventory. Chugach National Forest, Anchorage, Alaska.

Labell, M. 1992. Straying patterns of coho salmon (*O. Kisutch*) stocks from southeast Vancouver Island, British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 49: 1843-1855.

McMahon, T. E. and J. C. Tash 1988. Experimental analysis of the role of emigration in population regulation of desert pupfish. Ecology 69: 1871-1883.

Morrow, J. E. 1980. The freshwater fishes of Alaska. Alaska Northwest Publishing Company, Anchorage, Alaska. 248 pages.

Murphy, D. D. and B. R. Noon 1992. Integrating scientific methods with habitat conservation planning: reserve design for northern spotted owls. Ecological Applications 2: 3-17.

Noon, B. R. and K. S. McKelvy 1992. Stability properties of the spotted owl metapopulation in southern California. *In* The California spotted owl: a technical assessment of its current status. USDA Forest Service, PSW-GTR-133, Portland, Oregon.

Northcote, T. G. 1992. Migration and residency in stream salmonids--some ecological considerations and evolutionary consequences. Nordic Journal of Freshwater Research 67: 5-17.

Ricker, W. W. 1972. Heredity and environmental factors affecting certain salmonid populations. Pages 19-160 *in* R. C. Simon and P. A. Larkin, editors. The stock concept in Pacific Salmon. H. R. MacMillan Lectures in Fisheries. University of British Columbia Press, Vancouver, British Columbia.

Rieman, B. E. D. Lee, J. McIntyre, K. Overton, and R. Thurow 1993. Consideration of extinction risks for salmonids. FHR Currents. Fish Habitat Relationships Technical Bulletin, Number 14, December 1993. U. S. Government Printing Office. 1993-583-068.

Shaffer, M. L. 1987. Minimum viable populations; coping with uncertainty. Pages 69-86 *in* M. E. Soule, editor. Viable Populations for Conservation. Cambridge University Press, Cambridge, England.

Simon, R. C. 1972. Gene frequency and the stock problems. Pages 161-169. *In* R. C. Simon and P. A editors. The stock concept in Pacific Salmon. H. R. MacMillan Lectures in Fisheries. University of British Columbia Press, Vancouver, British Columbia.

USDA, Forest Service 1992. Channel Type User Guide: Tongass National Forest Southeast Alaska. R10 Technical Paper 26, April 1992.

PERSONAL COMMUNICATIONS

Gillikin, D. January 1998. Glacier Ranger District, Chugach National Forest. Girdwood, Alaska.

Reeves, G. January 1998. Restoration Workshop, Anchorage, Alaska.

2000 EXXON VALDEZ TRI E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$18.0
Travel		$0.0
Contractual		$0.0
Commodities		$7.4
Equipment		$0.0
Subtotal	$0.0	$25.4
General Administration		$2.7
Project Total	$0.0	$28.1
Full-time Equivalents (FTE)		0.5
Other Resources		$12.3

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		$26.0	$5.0		

Dollar amounts are shown in thousands of dollars.

Comments: New project proposal

FY00

Project Number: 00383
Project Title: Distribution Study of CT/DV in PWS
Agency: U. S. Forest Service

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:4/14/99, KEH

2000 EXXON VALDEZ TRL E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
R. Spangler	PI - Fish Biologist	GS-9	1.5	4.5		6.8
Vacant	Bio tech	GS-7	1.5	2.8		4.2
Vacant	Bio tech	GS-5	1.5	2.3		3.5
Vacant	Bio tech	GS-5	1.5	2.3		3.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		6.0	11.9	0.0	
					Personnel Total	$18.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
					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

FY00

Prepared:

Project Number: 00383
Project Title: Distribution Study of CT/DV in PWS
Agency: U. S. Forest Service

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed FY 2000
Description	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed FY 2000
Description	
train ticket (personal)	0.2
Train ticket (truck)	0.6
camp food ($18.00/ day for 120 days)	2.1
boat rental (30 days @ $150.00/ day	4.5
Commodities Total	$7.4

FY00

Prepared:

Project Number: 00383
Project Title: Distribution Study of CT/DV in PWS
Agency: U. S. Forest Service

FORM 3B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRL E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2000
Description			
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number of Units	Inventory Agency
Description		
the following Forest service equipment (not purchased by EVOS) are being contributed to this project.		
landing craft ($200.00/ day for 30 days		6
skiff and motor for 30 days		3.5
camp and supplies		2.8
		12.3

FY00

Project Number: 00383
Project Title: Distribution Study of CT/DV in PWS
Agency: U. S. Forest Service

FORM 3B
Equipment
DETAIL

Prepared:

3-D Ocean State Simulations for Ecosystem Applications from 1995-1998 in Prince William Sound, Alaska

Project Number:	00389
Restoration Category:	Research
Proposer:	University of Alaska Fairbanks
Lead Trustee Agency:	ADFG
Cooperating Agencies:	
Alaska Sea Life Center:	No
Duration:	1st year, 2-year project
Cost FY 00:	$133,456
Cost FY 01:	$79,660
Geographic Area:	
Injured Resource/Service:	

ABSTRACT

Using the observed data collected from 1995–1998 in PWS and the forcing of tide, coastal current inflow/outflow, freshwater discharge, and wind stress, a 3-D PWS model developed from the SEA Project (Wang and Ikeda 1996; Mooers and Wang 1998; Wang et al. 1999a, b) will be used to produce a continuous 4 year, 3-D fields of velocity, temperature, salinity and mixing coefficients for the resource managers, fishing industry and biological applications, because in the SEA, only 1996 physical forcing has been provided. In addition, the interannual variability of PWS ocean circulation, temperature and salinity due to interannually variable atmospheric forcing will be studied. Thus, we can identify the key environmental parameters to be included in a long-term monitoring program to assist resource managers.

INTRODUCTION

In the SEA program, extensive observations of phytoplankton and zooplankton, as well as oceanography, have been made during 1995–1998 (Cooney, 1996, 1997; McRoy et al. 1997; Thomas et al. 1997; Vaughan et al. 1999). Fish larvae and schools of some kinds were also measured (Stokesbury et al. 1997). The 3-D ocean circulation model explains some mechanisms and application to biology (Mooers and Wang 1998). For example, the oceanic advection and diffusion only can explain the existing phytoplankton and zooplankton movement, while the spring blooms and sometime the later summer blooms (i.e., second bloom in the year) due to the ecosystem dynamics cannot be explained by a physical only model.

Recently, the substantial progress has been made for the PWS ocean circulation modeling in the following subjects:

1. We have implemented the freshwater discharge of a line source into PWS (Wang et al. 1999) with support from the SEA funding last November to April 1999 (for Dr. M. Jin) and continued conducting seasonal (12-month) simulation under climatological forcing and under seasonal forcing (1996) collaborating with Dr. S. Vaughan. The tidal forcing was also implemented to the forcing function.

2. We have conducted the (1996) seasonal 3-D simulation (for Dr. T. Cooney) of PWS zooplankton overwintering, releasing the particles from the depths below 400m on February 1 through July 30, 1996 (see Fig. 2), with an assumed mortality rate of 6% day^{-1}. The simulated results are consistent with what was been observed in 1996, according to Dr. T. Cooney.

3. We have conducted the (1996) seasonal simulation (for Dr. B. Norcross) of spawning larvae migration along the a few selected locations (Fig. 3). The duration larvae retention in PWS has been found shorter by the change of the spawning location due to the 1989 T/V Exxon oil spill event. The mortality rate of 5% day^{-1} was assumed.

4. We also provided 3-D velocity fields to E. Brown for her research (Brown et al. 1999), because she found that physical forcing from the 3-D model fits well with her biological data. Thus, she strongly urges us to provide four consecutive years (1995–1998) of the 3-D current velocity, temperature and salinity for her continuous proposal to EVOS.

NEED FOR THE PROJECT

A. Statement of Problem

1. Use 1995–1998 CTD observations combined with the historical CTD observation from 1975–1994 to produce updated climatology of T and S for each levels (such as surface, 5m, 10m, ...). This will be collaborated with PWSSC colleagues (V. Patrick et al.).

2. Use 1995–1998 wind speeds and directions at nine weather stations around PWS to produce four-year spatial varying wind fields. This will be collaborated with PWSSC colleagues (V. Patrick and J. Allen).

3. Calculate 1995–1998 freshwater discharge using a hydrological model under forcing of air temperature, river runoff, and precipitation.

4. Using the above 1)-3) as forcing, we will simulate the 3-D PWS ocean circulation, T, S, etc. using 3D-PWS model (Wang et al. 1999) to provide biologists and resource managers with applications of the physical forcing model.

5. Analyze continuous 48-month interannual variability of PWS circulation, T, S, and other variables under atmospheric forcing.

B. Rationale/Link to Restoration

Prince William Sound (PWS or the Sound) is located in the southern coast of the Gulf of Alaska (GOA). PWS is a combination of fjords and estuaries along the coast of Alaska which was formed by a combination of preglacial erosion, glacial excavation, and tectonism. A systematic numerical simulation (study) of the physical oceanography and ecosystem in the region is essential and timely to understand the physical-biological system in order to provide scientific knowledge and information to the state government, local community, etc. Because of its rich resources in sea birds, mammals, salmon, forage fish, and many other animals,

There were few historical observational studies before 1989. Possibly because the North America's largest oil spill by T/V Exxon Valdez on March 24 1989 seriously damaged the ecosystem in PWS and the adjacent downstream waters, such as Cook Inlet and Kachemak Bay, extensive observational programs have been carried out in PWS. The SEA (Sound Ecosystem Assessment) project is a major effort since. This interdisciplinary project started in 1994 with major focus on pink salmon, Pacific herring habitat, ecology, and physical oceanography. As the physical component, the effort was placed on field program and numerical modeling.

After the implementation of 3D-PWS model and a passive tracer simulation were accomplished (Mooers and Wang 1998; Deleersnijder et al 1998), a seasonal simulation (12 consecutive months) has been followed up by Wang et al. (1999) using the SEA observations of 1996 only (Fig. 1). However, the field observations in physical and biological oceanography from 1995–1998 during the SEA program have not fully validated. In addition, the interannual variability as observed (Vaughan et al. 1999) can not be explained in terms of numerical modeling. Thus, after the SEA, it is necessary to synthesize both observations and multi-year modeling for 1995–1998.

Thus, it is highly appropriate to use the data that has already been collected during the SEA project to synthesize results of this multi-year oceanographic model simulation along with results from the SEA Project and other resources. The simulated results will be valuable to assist resources managers to forecast pink salmon and Pacific herring abundance and to anticipate or understand changes in the ecosystem. In addition, key elements will be identified that will be pertinent to include in a long-term monitoring program, leading to an establishment of a nowcast/forecast system in PWS using this 3D-PWS model.

C. Location

The research objective is the ecosystem of Prince William Sound that will help understanding the basic physical forcing of the Sound and benefit to the biological research community and resource managers. The observed data used in the model are from the observation conducted in

PWS within 4 years (1995 to 1998).

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Not only the research institutions (such as IMS and IARC of UAF), but also the local community (Regional citizens' Advisory Council, RCAC, at Cordova and Cook Inlet) will be involved. They are concerned with possible long-term oil spill impact on the ecosystem and local community as well.

PROJECT DESIGN

A. Objectives

1. Using the 3D-PWS model to simulate 1995–1998 ocean circulation, T, S, vertically mixing coefficients using 2.5 turbulence closure model. The model validation will be conducted using actual observations during the four years.

2. Provide biologists and resource managers the 3-D fields (longitude, latitude, and depth) of velocity, T, S, etc. of 1995–1998.

3. Conduct 48-month simulation of zooplankton overwintering for each year to compare the early spring distribution, the late spring-summer distribution, and the year-to-year difference (interannual variability).

B. Methods

The above objective will be implemented with the method of physical and biological data analysis and 3-D PWS numerical model.

1. Forcing data
    i. Winds. The hourly wind speeds and directions will be analyzed at the nine stations around PWS, as used in Wang et al. (1999). Using 9 wind-fetch empirical model, the winds will be interpolated into the model grids from 1995–1998. This work will be subcontracted to Dr. Patrick and Allen at PWSSC.

    ii. The SEA CTD data from 1995–1998. All the CTD data from SEA, both physical oceanography observations and biological observations will be collected to produce seasonal T and S distribution from 1995–1998. This work will be also subcontracted to Dr. Vaughan at PWSSC to provide us the data.

    iii. The hydrological model for freshwater discharge into PWS will be run to produce the 4-year daily runoff. The work will be done at UAF.

    iv. Monthly heat flux for the same period will be extracted from the COADS.

    v. The monthly inflow/outflow will be fixed to the observations of Niebauer et al. (1994).

2. Model simulations
The ocean circulation (physical) model should refer to the studies of Wang and Ikeda (1996), Wang et al. (1997), Mooers and Wang (1998), and Wang et al. (1999).

A continuous 48-month simulation will be conducted under the forcing described above and tidal forcing, beginning from January 1995 to December 1998. The outputs will be validated based on actual observations. Then, the model outputs (velocity, T, S, mixing coefficients, etc.) in 3D grids will be provided to biologists who need these outputs to verify their phytoplankton and zooplankton data. The interannual variability in these four years will be analyzed to confirm what (i.e., which forcing factor) causes interannual variability, and their relative importance for interannual variability.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The data preparation will be subcontracted to PWSSC (Drs. Patrick and Allen) because the observations of SEA Project in 1995–1998 were done by them and we had very fruitful co-operation in the SEA Projects.

SCHEDULE

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

December 31:	Complete tide simulation and validation with the 4 year's observation
January 18–28 (3 of these days):	Attend Annual Restoration Workshop
March 31:	Complete preparing the forcing data of the four years
August 31:	Complete the modelling of 1995–1998
September 15:	Submit manuscript to peer viewed journal

B. Project Milestones and Endpoints

December 31, 1999:	Complete tide simulation and validation with the 4 year's observation
March 31, 2000:	Complete preparing the forcing data of the four years
August 31, 2000:	Complete the modelling of 1995–1998
September 15, 2000:	Submit manuscript to peer viewed journal
March 15, 2001:	Complete the analysis of interannual variability of the ocean circulation and the ecosystem in PWS
April 15, 2001:	Submit annual report (FY 00)
August 15, 2001:	Complete the modelling of zooplankton overwintering
September, 30, 2001:	Submit final report

C. Completion Date

September 30, 2001

PUBLICATIONS AND REPORTS

Manuscript (entitled "Simulating interannual variability of ocean circulation of PWS, Alaska"; to be submitted Journal of Geophysical Research-Oceans) will be prepared and submitted to a refereed journal for formal publication. I may present the results and publish another paper in the book entitled "Computer Modeling of Seas and Coastal Regions, V, 2001" in which I serve as a member of the International Advisory Committee for three years now.

PROFESSIONAL CONFERENCES

The PI and Dr. Jin plan to attend the annual EVOS meeting, Fall AGU Meeting in San Francisco or Ocean Sciences Meeting on January 2000 in San Antonio, presenting the updated research results. This is an excellent way to communicate with our colleagues and to get recognized in the ocean science community. During the first year, we will travel to Cordova discussing with Dr. Patrick and Allen regarding data processing and analysis.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This proposed research will be coordinated with 1) E. Brown's project (if her proposal gets funded) by providing her with the model outputs; 2) S. Vaughan's proposal for continuous monitoring project; 3) J. Allen's proposal for animation of 3-D model outputs, and other potential proposals for the restoration effort. We are willing to provide our 4-year simulation outputs to all EVOS-funded proposals by putting our simulation results on our web in both digital and graphic formats.

PROPOSED PRINCIPAL INVESTIGATOR

Jia Wang
Institute of Marine Science
University of Alaska Fairlbanks
P.O. Box 757220
Fairbanks, Alaska 99775-7220
907-474-6877
907-474-7204
jwang@ims.uaf.edu

PRINCIPAL INVESTIGATOR

Dr. Jia Wang, the PI, will be involved in the entire course of the project, providing scientific guidance to the project, without claiming salary. The PI needs one graduate student to conduct hydrological model to produce 48-months of freshwater runoff along the PWS coasts.

OTHER KEY PERSONNEL

Dr. Meibing Jin, who is currently working on the OSRI-funded project awarded to Dr. V. Patrick of PWSSC, will continue conducting the simulation, and will partially supported by the requested fund for six months, plus UAF overhead (25%), benefit, and travel to scientific conferences/workshops.

The data preparation will be subcontracted to PWSSC (Drs. Patrick and Allen).

LITERATURE CITED

Brown, E.D., J. Wang, S.L. Vaughan, and B.L. Norcross, 1999. Identifying seasonal spatial scale for the ecological analysis of herring and other forage fish in Prince William Sound, Alaska. *In* Ecosystem Approaches for Fisheries Management, Alaska Sea Grant College Program AK-SG-99-01 (in press)

Cooney, T. 1996. SEA–An Integrated Science Plan for the Restoration of Injured Species inPrince William Sound. EVOS FY 1996 Annual Report.

Cooney, T. 1997. SEA–An Integrated Science Plan for the Restoration of Injured Species in Prince William Sound. EVOS FY 1996 Annual Report.

Deleersnijder, D., J. Wang, and C. Mooers. 1998. A two-compartment model for understanding the simulated three-dimensional circulation in Prince William Sound, Alaska. *Cont. Shelf Res.*, 18: 279–287.

Eslinger, D.L. 1997. Biological modeling and validation through remote sensing. *In* Chapter 5, SEA–An Integrated Science Plan for the Restoration of Injured Species in Prince William Sound. T. Cooney (ed.). EVOS FY 1997 Annual Report.

McRoy, C.P. 1997. Sound ecosystem analysis: phytoplankton and nutrients. *In* Chapter 3, SEA–An Integrated Science Plan for the Restoration of Injured Species in Prince William Sound. T. Cooney (ed.). EVOS FY 1997 Annual Report.

Mooers, C.N.K. and **J. Wang**. 1998. On the development of a 3-D circulation model for Prince William Sound, Alaska. *Cont. Shelf Res.*, 18: 253–277.

Niebauer, H.J., T.R. Royer, and T.J. Weingartner, 1994. Circulation of Prince William Sound, Alaska. *J. Geophys. Res.*, 99: 14,113–14,126.

Stokesbury, K.D.E., E.D. Brown, R.J. Foy, and B.L. Norcross. 1997. Juvenile herring growth and habitats. *In* Chapter 11, SEA–An Integrated Science Plan for the Restoration of Injured Species in Prince William Sound. T. Cooney (ed.). EVOS FY 1997 Annual Report.

Thomas, G.L., K. Jay, G. Steinhart, and N. Peters. 1997. Nekton-plankton acoustics. *In* Chapter 10, SEA–An Integrated Science Plan for the Restoration of Injured Species in Prince William Sound. T. Cooney (ed.). EVOS FY 1997 Annual Report.

Vaughan, S.L. C.N.K. Mooers, J. Wang, S.M. Gay, and L.B. Tuttle. 1999. Physical processes that influence the biological components of Prince William Sound (submitted to the SEA Synthesis Volume)

Wang, J. and M. Ikeda. 1996. A 3-D ocean general circulation model for mesoscale eddies-I: meander simulation and linear growth rate, *Acta Oceanologica Sinica*, 15: 31–58.

Wang, J., C.N.K. Mooers, and V. Patrick. 1997. A three-dimensional tidal model for Prince William Sound, Alaska. *In* Computer Modelling of Seas and Coastal Region III, J.R. Acinas and C.A. Brebbia (eds.), Computational Mechanics Publications, Southampton, pp 95–104.

Wang, J., V. Patrick, J. Allen, and M. Jin. 1999a. Modeling seasonal ocean circulation of Prince William Sound, Alaska using freshwater of a line source. *In* Computer Modelling of Seas and Coastal Region IV, C.A. Brebbia, et al. (eds.), Computational Mechanics Publications, Southampton (in press).

Wang, J., V. Patrick, J. Allen, S. Vaughan, C. Mooers, D. Eslinger, T. Cooney, and M. Jin. 1999b. A simulation of the seasonal ocean circulation patterns/regimes of Prince William Sound, Alaska, 1996 (submitted to the SEA Synthesis Volume).

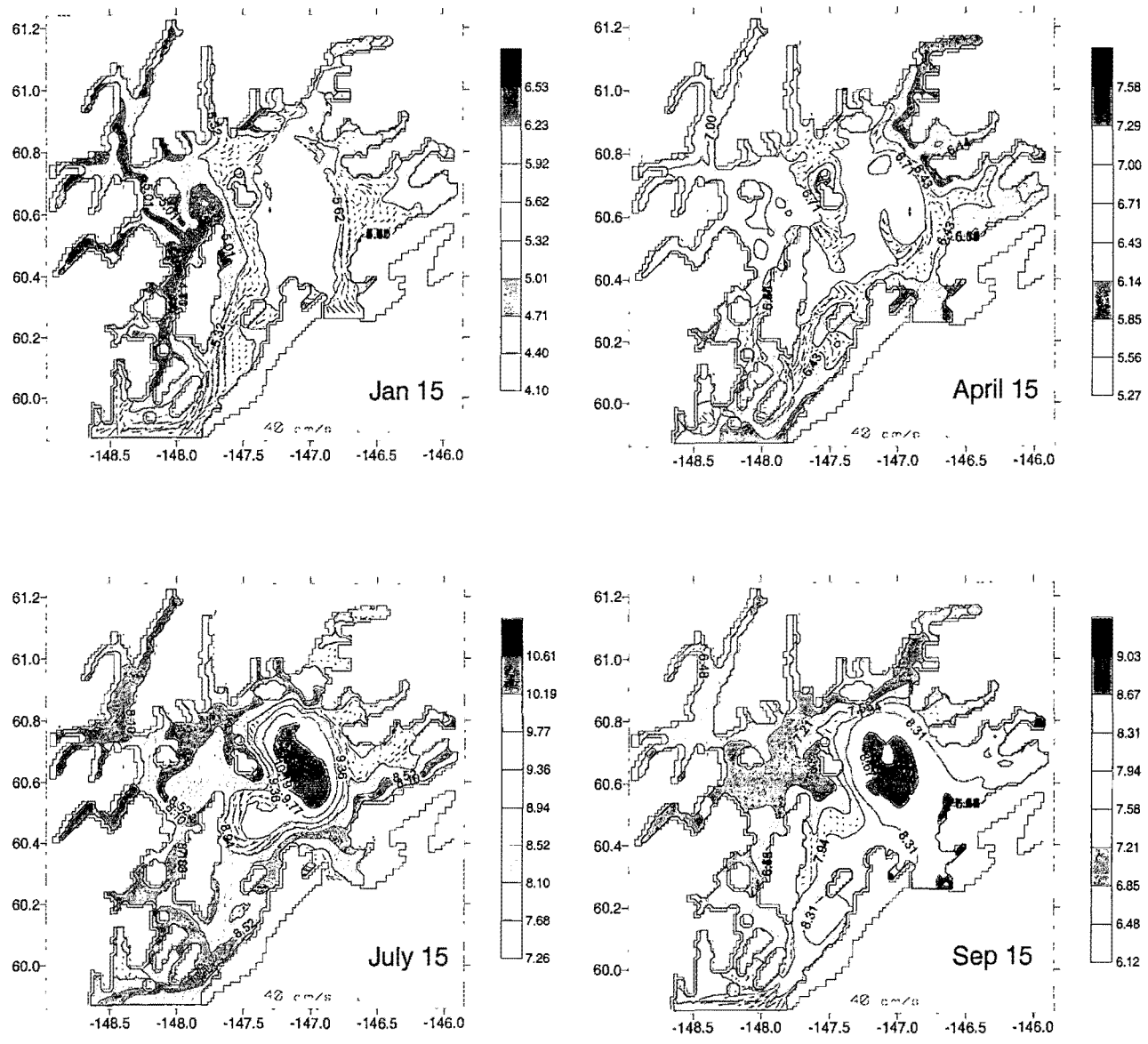
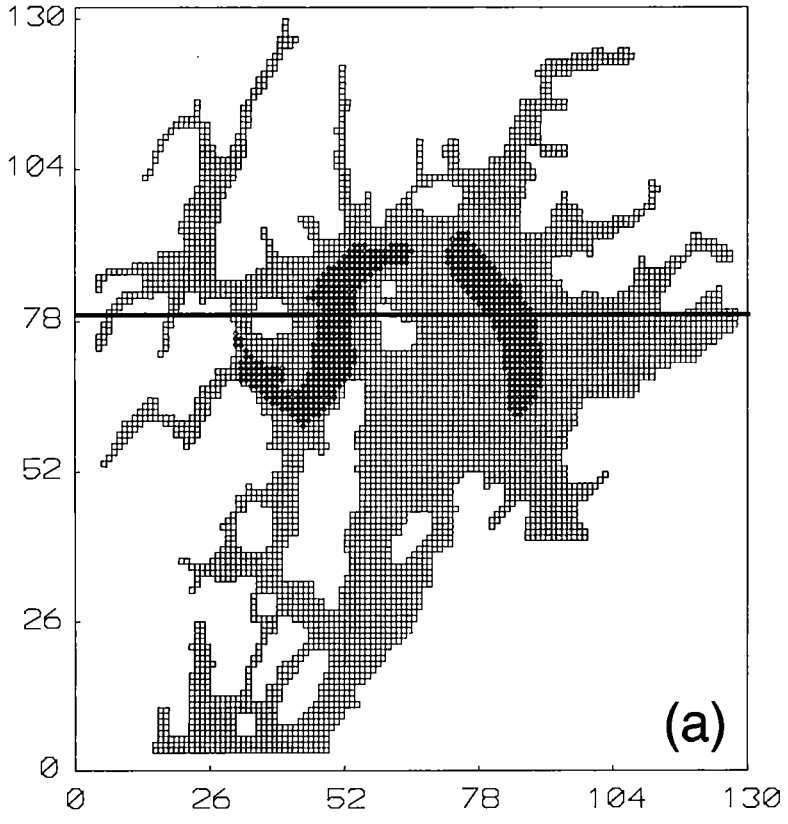


Figure 1. The 1996 seasonal simulation of surface circulation patterns superimposed by the surface sea temperature for Jan 15, April 15, July 15, and Sep 15.



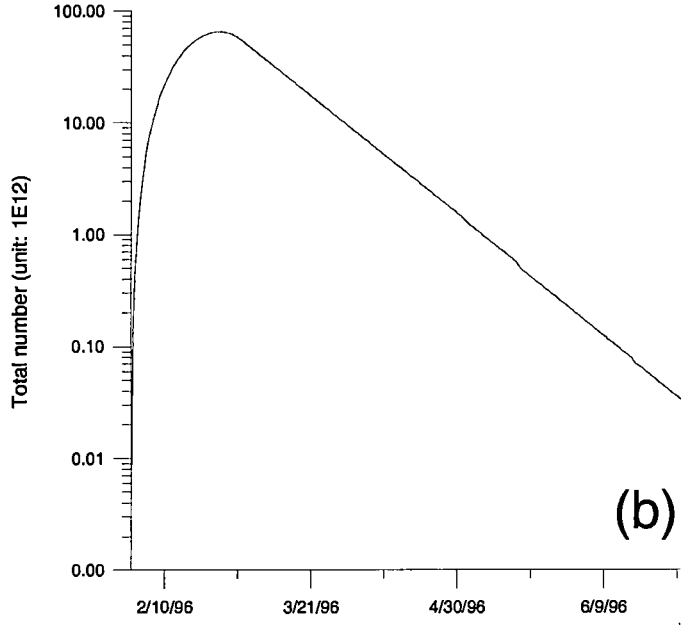


Figure 2. PWS zooplankton release simulation: (a) The overwintering release grid points under 400m on February 1, 1996 (the solid line is the transect shown in c and d); (b) The changes of the total number of zooplankton with time; A transect (at 60.75N) view of the zooplankton distribution on (c) Feb. 11, (d) April 1; and a plan view of the distribution on (e) April 21, and (f) June 11.

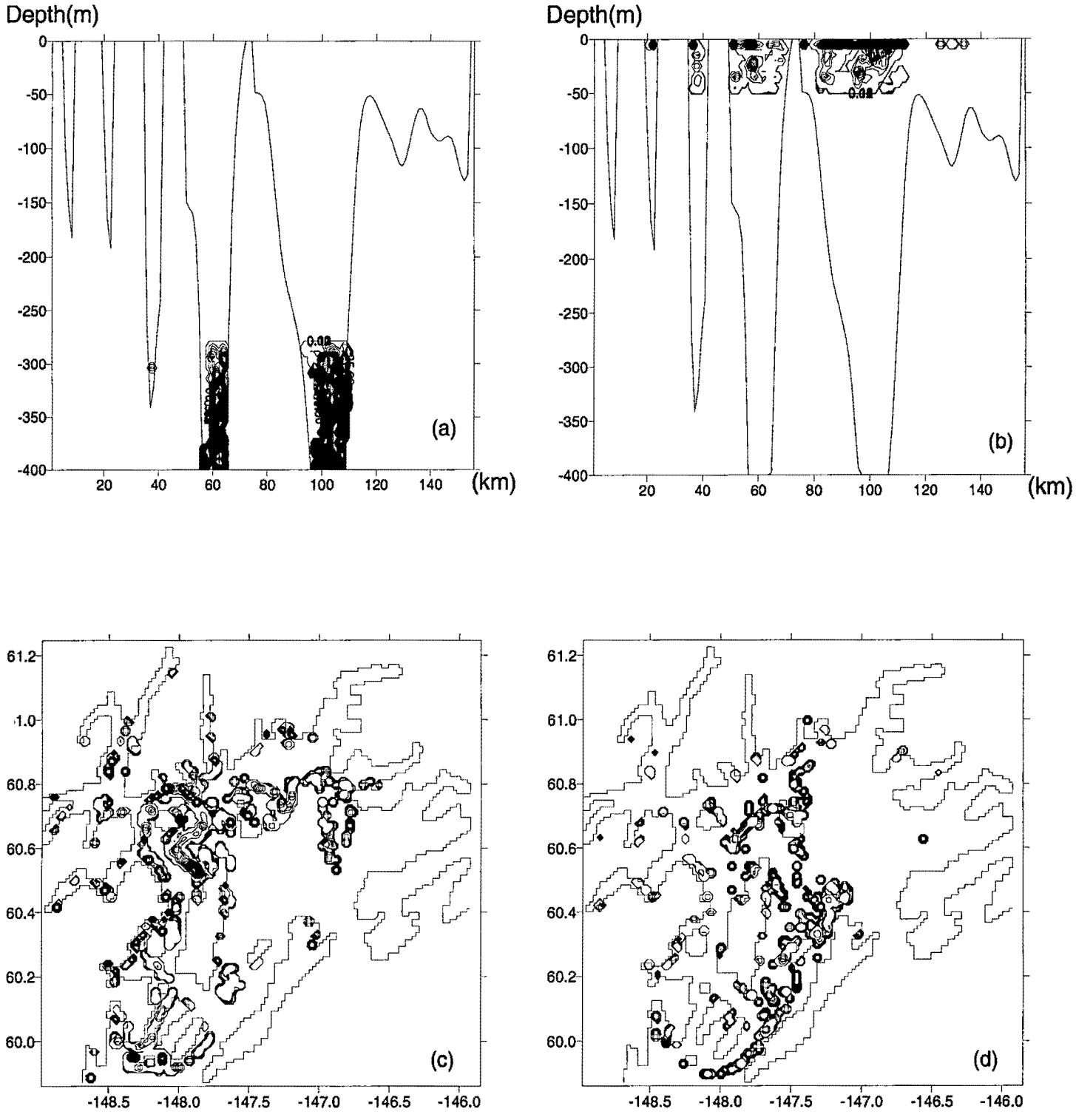


Figure 2. (Continued)

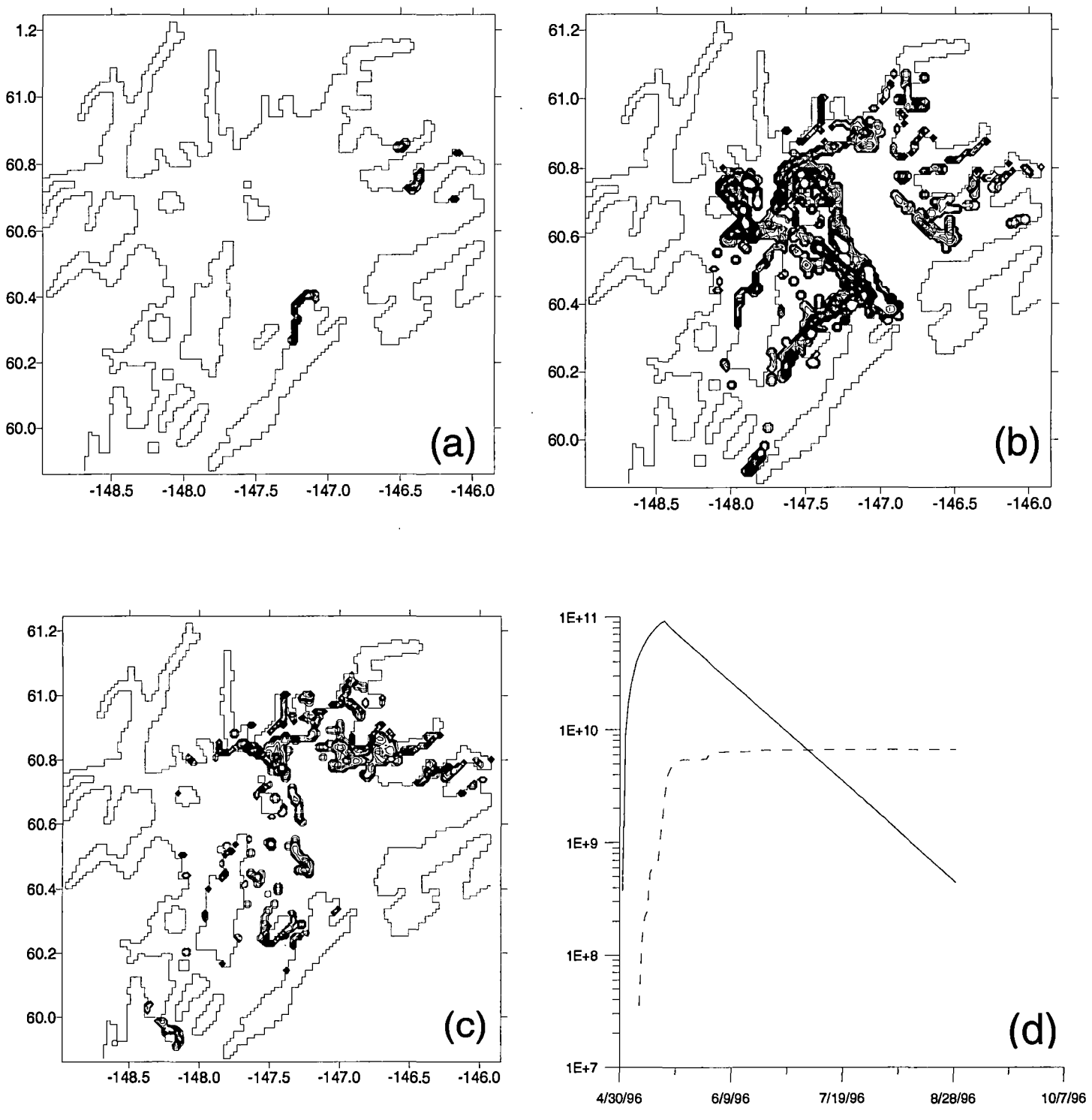


Figure 3. PWS larvae migration simulation: The release concentration on (a) May 1, (b) June 1, (c) July 1; and (d) Changes of the total larvae number with time (Solid line: total number in PWS and dashed line: total number flowing out of PWS).

2000 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$0.0
Travel		$0.0
Contractual		$133.5
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$133.5
General Administration		$9.3
Project Total	$0.0	$142.8
Full-time Equivalents (FTE)		1.5

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		

Dollar amounts are shown in thousands of dollars.

Other Resources								

Comments:

FY00

Prepared:

Project Number: 00389
Project Title: 3-D Ocean State simulations for Ecosystem Applications from 1995-1998 in Prince William Sound, Alaska
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$47.4
Travel		$3.0
Contractual		$61.0
Commodities		$1.0
Equipment		$0.0
Subtotal	$0.0	$112.4
Indirect		$21.1
Project Total	$0.0	$133.5
Full-time Equivalents (FTE)		1.5
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		$79.7			

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.

Student personnel costs include non-resident tuition of $5,868 per year.

FY00

Prepared:

Project Number: 00389
Project Title: 3-D Ocean State simulations for Ecosystem Applications from 1995-1998 in Prince William Sound, Alaska
Name: Jia Wang

FORM 4A
Non-Trustee
SUMMARY

2000 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 2000
M. Jin	Research Assistant Professor		6.0	4.9		29.4
TBA	Graduate Student		12.0	1.5		18.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		18.0	6.4	0.0	
					Personnel Total	$47.4

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 2000
R/T Fairbanks to Cordova (AGU meetings)		1.0	2	8	1.0	3
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$3.0

FY00

Prepared:

Project Number: 00389
Project Title: 3-D Ocean State simulations for Ecosystem Applications from 1995-1998 in Prince William Sound, Alaska
Name: Jia Wang

FORM 4B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
Publications (telephone, copying, postage, etc.)	1.0
Subcontract: Prince William Sound Science Center	60.0
Contractual Total	$61.0

Commodities Costs:	Proposed
Description	FY 2000
Project supplies	1.0
Commodities Total	$1.0

FY00

Prepared:

Project Number: 00389
Project Title: 3-D Ocean State simulations for Ecosystem Applications from 1995-1998 in Prince William Sound, Alaska
Name: Jia Wang

FORM 4B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2000
			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	

FY00

Prepared:

Project Number: 00389
Project Title: 3-D Ocean State simulations for Ecosystem Applications from 1995-1998 in Prince William Sound, Alaska
Name: Jia Wang

FORM 4B
Equipment
DETAIL

April 13, 1999

Dear Dr. Wang,

We are pleased to confirm our intent to participate in the proposed project entitled "3-D Ocean State Simulations for Ecosystem Applications from 1995-1998 in Prince William Sound, Alaska".

The statement of work shows the extended collaboration upon which this work will draw. Dr. J. R. Allen, Mr. S. Bodnar, and Dr. V. Patrick from Prince William Sound Science Center hereby acknowledge their interest and intent to work with you to realize the goals and objectives described in your project plan.

We all look forward to again delivering a successful project and a relevant and valuable application that builds upon the resources that we have jointly developed.

Sincerely,

Stephen Bodnar

V. J. Patrick

Vincent Patrick

Prince William Sound Science Center

From jrallen@pwssc.gen.ak.us Tue Apr 13 00:54 AKD 1999
From: Jennifer Allen <jrallen@pwssc.gen.ak.us>
Date: Tue, 13 Apr 1999 00:49:21 -0800 (AKDT)
To: jwang@chukchi.iarc.uaf.edu
Subject: letter of intent
Cc: patrick@grizzly.pwssc.gen.ak.us
Content-Type: text
Content-Length: 841

April 13, 1999

Dear Dr. Wang,

I am pleased to write to you to confirm that I will participate in your research project entitled "3-D Ocean State Simulations for Ecosystem Applications from 1995-1998 in Prince William Sound, Alaska". In collaboration with you, Dr. Vince Patrick at the Prince William Sound Science Center, and Dr. David Eslinger at the NOAA Center for Coastal Studies in Charlston SC, I will be continuing development of a spatial wind algorithm and applying it to generate additional years of forcing data for your circulation model. I will also be involved in 3-dimensional visualization and animation of simulation results.

I look forward very much to the opportunity to continue this work with you. Thank you for the opportunity.

Sincerely,

ennifer R. Allen for J.R.
Prince William Sound Science Center

---

ummary of contributing efforts for Proposal 00389

This project subcontract will provide the following to the project described in Proposal 00389 to EVOSTC.

1. Surface wind fields for Prince William Sound for the years 1995-1998 will be provided using the expert system for domain partitioning and zero-order tangent bundle section interpolation scheme developed by Allen, Bodnar, Eslinger, and Patrick.

   This scheme provides a low-cost, interim alternative to the development of a high resolution numerical model for surface winds. The method makes full use of all existng surface wind observations (all stations, any reporting interval) in a manner that is consistent with existing local knowledge regarding weather system dependent wind-field patterns. The present version incorporates the knowledge of pilots of small commercial aircraft into a series of weather system dependent production rules for domain partitioning.

   Personnel: J. R. Allen 2.0 mo.
   S. Bodnar 1.0 mo.
   V. Patrick no charge

   Co-funding: Oil Spill Recovery Institute contract 99-10-5
   January 01 1999 -- December 31 1999
   $133,000

   "Information Systems for the Demonstration of a Nowcast/Forecast System for Prince William Sound Circulation"
   Principal Investigator: V. Patrick

   Collaborating Personnel: D. Eslinger, NOAA

2. Design of user- and application-specific information formats for the datasets resulting from the simulations of this effort. Prototypes in the form of scientific visualizations and scientific data formats will be implemented and evaluated.

   Personnel: J. R. Allen 1.0 mo.

3. Incorporation of zooplankton advection simulation results into the program for the assessment and optimization of hatchery procedures conducted with the Prince William Sound Aquaculture Corp.

   Personnel: V. Patrick 0.5 mo.
   R. T. Cooney travel and per diem reimbursement

   Collaborating personnel: M. Willette ADFG

   Co-funding:
   (1) Oil Spill Recovery Institute contract 99-10-5
   January 01 1999 -- December 31 1999
   $133,000

   "Information Systems for the Demonstration of a Nowcast/Forecast System for Prince William Sound Circulation"
   Principal Investigator: V. Patrick

(2) Advanced Visualization Laboratory, University of Maryland
(salary and computing resources for V. Patrick)

(3) Institute for Systems Research, University of Maryland
pending: Systems and control applications realizable with the ecosystem production and species interaction models for PWS, AK

(4) Oil Spill Recovery Institute post-doctoral grant for Meibing Jin, IARC

4. A first formulation for an ecosystem model capable of forecasting the occurrance of the spined phytoplankton species Chaetoceros. The species occurs in large numbers only rarely in PWS. Due to the spined structure its presence severly injures fish species resident in the upper layers of the water column during the spring phytoplankton bloom. It has devastating effects upon juvenile fish unable to avoid the phytoplankton and can account for up to 80% loss in exposed hatchery pens. The combined models for circulation and phytoplankton are sufficiently developed to be capable of predicting the occurrance of the species once the conditions favoring its dominance are identified. A first set of conjectures for these conditions will be developed. A plan will be developed for testing these conjectures through the use of the circulation model and the phytoplankton model.

Personnel: V. Patrick 0.5 mo.
R. T. Cooney travel and per diem reimbursement

Collaborating personnel: M. Willette, ADFG
D. Eslinger, NOAA

Co-funding:

(1) Advanced Visualization Laboratory, University of Maryland
(salary and computing resources for V. Patrick)

(2) Institute for Systems Research, University of Maryland
pending: Systems and control applications realizable with the ecosystem production and species interaction models for PWS, AK

(3) Oil Spill Recovery Institute post-doctoral grant for Meibing Jin, IARC

(4) Oil Spill Recovery Institute grant to J. Wang, IARC, for phytoplankton application development

Cook Inlet Information Management/Monitoring System

Project Number:	00391
Restoration Category	Monitoring
Proposer:	ADEC/ADNR
Lead Trustee Agency	ADEC/ADNR
Cooperating Agencies	USEPA, USGS, USFS, ADF&G
Alaska SeaLife Center	N/A
Duration:	1 Year (2nd year of 2 year project)
Cost FY 99:	$335.0
Cost FY 00:	$794.1
Geographic Area	Cook Inlet
Injured Resource/Service:	All

ABSTRACT

The Cook Inlet Information Management/Monitoring System (CIIMMS) will permit a wide range of users with the opportunity to share and access valuable information and data about the Cook Inlet watershed and Cook Inlet-related activities. CIIMMS potential users include educators, scientists, students, researchers, resource managers, private organizations and individual citizens. CIIMMS will provide an interactive website for the Cook Inlet community to efficiently and effectively contribute, identify, and access relevant information from a distributed network of providers.

INTRODUCTION

The Cook Inlet Information Management/Monitoring System (CIIMMS), Project 99391 was funded in FY 99 to conduct a User Needs Analysis and develop a prototype system as an evaluation tool useful for development of a final set of system specifications. Deliverables associated with the FY99 effort include:

1. User Needs Analysis – completed February 28, 1999.
2. Identification and Preliminary Prioritization of Datasets – completed February 1999.
3. Prototype – expected completion date, August 31, 1999.
4. Preliminary System Specifications – expected completion date, September 30, 1999.

To ensure CIIMMS is a valuable tool for a diverse community of information users and providers, the CIIMMS Project Team conducted an extensive User Needs Analysis that included:

- Compiling a database of probable users and/or information suppliers.
- Distributing a comprehensive 60-question survey to all contacts in the database, compiling and analyzing the results.
- Conducting project briefings and discussion groups in communities and organizations in the watershed.
- Conducting follow-up interviews with various survey respondents and participants.

The investigations of the User Needs Analysis covered the following topics:

- Inventory of products and/or output generated
  1. Impetus for information management efforts (e.g., mission statement, directive, work plan).
  2. Common information requests and/or analyses.
  3. Final products or output generated from Cook Inlet information/information management.
- Future activities
  4. Impetus for future activities.
  5. Summary of future activities.
  6. Information and data types and associated software, hardware, and telecommunication capabilities required to meet future activities.
- Information/data description
  7. Types and sources of data/information used and/or processed.
  8. Means of accessing information (telephone, email, ftp etc.).
- Information processing.
  9. Format and processing steps for information/data received.
  10. Format and processing steps for information/data generated.
- Vision or wish list for information management.
- Inventory of software, hardware, and telecommunications capabilities.

Information gained from these investigations was provided to participants at a User Needs Workshop held in January of 1999. Over 100 people attended the workshop to validate survey results and discuss the following questions:

- What questions should CIIMMS address?
- Which users should CIIMMS accommodate?
- What information should be included in CIIMMS?
- What should CIIMMS accomplish (system functions)?
- What products should CIIMMS be able to generate?
- What system design should CIIMMS adopt?
- How can we make CIIMMS happen?
- What kind of user interface should CIIMMS have?
- What information should be included in CIIMMS?

The results of this extensive user needs analysis forms the basis for a prototype implementation plan, scheduled for completion by April 30, 1999 Results of the user survey and workshop (Post Workshop Report) as well as the detailed prototype implementation plan (CIIMMS Implementation Plan) can be found on the CIIMMS web site at www.oilspill.state.ak.us. The implementation of the prototype focuses on short term priorities identified in the User Needs Analysis process in a limited geographic area, the Kenai River watershed (see Appendix A: "Design Summary for CIIMMS Prototype").

Short term priorities scheduled for inclusion in the prototype include the following features:

- Categorical indexes for Cook Inlet information inventory
- Keyword and advanced metadata searching
- Restoration project activities
- Ability to view, download, and print static maps and web documents (for not more than 10 priority data themes selected for use in the prototype)
- Metadata records linked to actual data and summary information (e.g., fact sheets), data quality documentation
- Hotlist of all related offsite links
- Form for suggesting information and links to add to clearinghouse
- Metadata entry tool to populate clearinghouse
- Training materials and a CIIMMS user manual

In the Initial Production Phase of CIIMMS (FY 00), with the prototype "framework" in place, the CIIMMS project team will focus on making additional datasets and information available to the CIIMMS community. The specifications for this phased-in approach to data and information integration will be implemented according to the specifications developed from the results of the prototype evaluation. Medium term priorities, as identified at the January 1999 user needs workshop, will be integrated into the CIIMMS system during FY 2000 (CIIMMS year 2).

Medium-term priorities include the following :

- Expansion of access to data and information, *including traditional ecological knowledge*, building on the few datasets available via the prototype, to include data for various watersheds throughout the Cook Inlet basin;
- Population of the metadata databases (both spatial and non-spatial metadata) for priority datasets for various watersheds throughout the Cook Inlet basin;
- Develop a web-accessible visualization tool.

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 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. 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).

Each year, industry, government, the scientific community and citizen watchdog groups generate and use large quantities of information about this area 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.

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 making and or reviewing management and policy decisions. Potential users of CIIMMS 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 may be considered for inclusion in the system.

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 accessible, 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 information about resources and relationships between resources and proposed development.

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 2000 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 in broad, ecological contexts. Having the benefit of these perspectives not only aids interpretation of past results in regard to injury and recovery, but also provides an improved framework for development of long-term restoration, research, monitoring, and management plans."

CIIMMS will contribute toward recovery of the *Exxon Valdez* oil spill injured resources and services by facilitating management and planning within the Cook Inlet watershed by improving access to information relative to injured resources/services and their habitats in the Inlet. CIIMMS

can provide a tool to help make Trustee Council funded research readily available to resource managers.

CIIMMS will help recovery of injured resources/services by facilitating management and monitoring efforts by:

1. Providing access to more complete resource information to decision-makers and the public.
2. Provide maps, publications, and data pertinent to injured species' habitats, movement corridors and environmentally sensitive areas.
3. Provide EVOS researchers and agency resource managers the ability to easily access and view a variety of metadata and datasets.
4. Provide information to regulators to help them review permit applications with recovery of injured resources/services in mind.
5. Provide a framework for analysis capabilities with base map and resource data, via a web accessible visualization tool.
6. Provide an easy tool for EVOS researchers and agency resource managers to contribute and share information on projects, reports, data, and funding sources, for coordination purposes.

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

To ensure that the proposed system will deliver the appropriate information in a format useful to stakeholders in the watershed and to ensure effective technical system implementation, a CIIMMS Advisory Group will be established to provide direction and feedback.

Membership of the advisory group will initially be derived from an existing group, known as the Cook Inlet Coalition, and supplemented by representatives from other stakeholder groups. The Cook Inlet Coalition is an organization facilitated by EPA to encourage the exchange of information and coordinate management and research efforts in Cook Inlet.

Ultimately, the advisory group membership will be representative of the following:

- A broad array of stakeholders to ensure that all potential users of CIIMMS information, from public citizens to government agencies, are represented

- Providers of spatial and non-spatial data (*all* data-providing and information-generating agencies and organizations should be represented, to the degree that this is possible)
- Providers of summary level information, such as public outreach materials
- Participants involved in all aspects of resource information management, from using information to creating databases.

A meeting of the Cook Inlet Coalition, in order to discuss the CIIMMS Advisory Group, is scheduled for May 11, 1999.

Traditional Ecological Knowledge

A medium-term priority of the stakeholders which surfaced at the CIIMMS user needs analysis workshop was the need to provide a tool for collecting traditional ecological knowledge (TEK), as well as providing access to it. Medium-term priorities for the CIIMMS project will be implemented during FY 2000.

A. Objectives

To provide a way for the Cook Inlet community (resource managers, scientists and researchers, educators, students, industry, and individual citizens) to identify, share and access valuable data and information about the Cook Inlet watershed from a distributed network of data and information providers.

B. Methods

The method and tasks outlined below encompass the design and development of a web-based information system, utilizing a hybrid centralized/distributed database design for both primary data and summarized information. Metadata for non-geospatial data will reside primarily on the CIIMMS site and geospatial metadata will be stored and accessed from the two Alaska clearinghouses currently in use for that exact purpose.

The proposed approach for implementing the Initial Production Phase of the Cook Inlet Information Management/Monitoring System includes the following steps:

Step 1: Continue evaluation and testing of CIIMMS prototype (deliverable 99391).

Step 2. Review preliminary system specifications (deliverable 99391).

Step 3: Develop final system specifications and implementation plan.

Step 4: Apply prioritization model for access/acquisition of additional datasets.

Step 5. Finalize data and metadata standards

Step 6: Provide guidance and metadata assistance to CIIMMS' data providers

Step 7: Expand number of distributed sites for access

Step 8: Design, develop and deploy visualization tools

Step 9: Develop a long range implementation, training, and maintenance plan.

Step 1. Continue evaluation of CIIMMS prototype.

Evaluation of the prototype developed as part of FY 99, 99391 will continue through the first quarter of this fiscal year in order to ensure that a large cross-section of the user community is given the opportunity to provide feedback. Training of potential users and subsequent evaluation of prototype functionality will be carried out by staff of DNR, DEC, and Cook Inlet Regional Citizen's Advisory Council.

The prototyping cycle is an iterative process that introduces the prototype to CIIMMS 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 into system specifications.

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

- Can CIIMMS effectively and efficiently provide a way for Cook Inlet users to identify, access, and contribute to Cook Inlet data and information, for the purpose of addressing specific resource questions?
- Does CIIMMS appeal to the diversity of users, their styles, and information needs?
- 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 CIIMMS feasible given the hardware, software and telecommunications capabilities of Cook Inlet stakeholders?
- Is CIIMMS easily accessible to users? Can data be accessed and acquired in a reasonable timeframe?
- Is desired data available and in a useable format?

Step 2. Review preliminary system specifications.

Preliminary system specifications developed as part of project 99391 will be posted on the CIIMMS web site for review and comment by the user community. The CIIMMS Advisory group will also meet to review and carefully analyze the preliminary system specifications and develop specific recommendations for incorporation into the final set of system specifications. Follow-up meetings with stakeholders will be conducted by the project team in order to ensure representation of the entire user community.

Step 3. Develop final system specifications and implementation plan.

After short-term functions are accepted in the pilot phase (see Appendix A: "Design Summary for CIIMMS Prototype"), the Initial Production Phase will be implemented. This phase will occur between October 1, 1999, and September 30, 2000. During this phase, all short- and medium-

term functions will be operational for the entire Cook Inlet watershed (see pages 3-4 for listings of short- and medium-term priorities).

The CIIMMS design will employ a hybrid centralized/distributed system, more centralized in the early stages, and then migrating towards a more distributed design. In the beginning, a few distributed sites plan to be accessible via CIIMMS. As agencies and organizations become more successful at providing access to their own data and information using emerging web technologies, CIIMMS will provide guidelines and technical support to enable the migration to a more distributed system. These pioneer sites will provide guidance to organizations interested in providing data and information access via CIIMMS.

CIIMMS data standards will be established through cooperation with the Alaska Geographic Data Committee and the CIIMMS Advisory Group. These standards will lay the technical foundation for CIIMMS to eventually incorporate new distributed technologies. Such technologies will allow the CIIMMS community to access and view spatial and tabular data without special software or having to download the data.

Step 4. Apply prioritization model for access/acquisition of additional datasets

Workshop discussions confirmed that there is a wide range of individuals, organizations, academic institutions, and government agencies that contribute to and use Cook Inlet information. This diverse user group generates and seeks access to all levels of information, including public documents, research and management documents, summarized public documents, processed data and primary data.

Through the CIIMMS User Needs Questionnaire and the User Needs Workshop two lists of user priorities for data were generated. The User Needs Questionnaire ranked 132 different data types/categories for short, medium and long term priority. From this list, User Needs Workshop participants selected a prioritized list of 37 of their top data needs. The list of user priorities is a heterogeneous set of data types, databases and data categories. In order to prioritize data sets to be included in CIIMMS, the following tasks have been or will be completed:

1) the user priorities from workshop were aligned with actual data sets in the CIIMMS data inventory; the result of this alignment is available upon request;
2) two sets of criteria (primary and secondary) will be applied sequentially to the aligned data list to further rank the data for inclusion into CIIMMS. The primary and secondary criteria are listed below:

   Primary criteria:

   - Importance to the success of the project
   - Resources needed to acquire the data
   - Effort required incorporating the data in CIIMMS
   - Update/long term maintenance requirements
   - Availability of information from multiple levels of the information pyramid
   - Geographic extent

Secondary criteria:

- Duplication and redundancy
- Scale
- Accuracy
- Status
- Currency
- Format
- Organization
- Adherence to data standards

These two sets of ranking criteria will be applied to the data sequentially. The first set will be used to create a prioritized list of data and data types for inclusion in CIIMMS. The second set of criteria will be used to select between data of the same type. Using the prioritization scheme as guidance, access to the datasets will be incorporated into CIIMMS.

Step 5. Finalize Data and Metadata Standards

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.

The CIIMMS project team will start with data standards for water quality, since data standards for water quality are driven largely by the US Environmental Protection Agency (EPA). EPA is currently working closely with US Geological Survey to evaluate and standardize common sampling and analytical methods related to water quality. Data *quality* issues have been addressed for the Kenai River watershed by The Nature Conservancy. See *Framework for Water Quality Monitoring of the Kenai River*[1] for details. The project team will investigate how this "framework" might be applied to the Cook Inlet basin. The production of a water quality data dictionary is a deliverable for this step, and will provide a template for additional applicable data themes.

Based upon user needs and input, project staff will adopt standards for process and content as required to meet user needs. The Cook Inlet Coalition/CIIMMS Advisory Group will provide ongoing review and feedback as these water quality standards are developed. These standards will set a target for data generators to meet. Current standards will be used where they already exist.

The starting point for developing CIIMMS metadata guidelines was a review of existing guidelines such as those developed for EPA's Chesapeake Bay program. The Chesapeake Bay Metadata Guidelines were developed through extensive stakeholder consensus-building within a watershed community of comparable geographic size to Cook Inlet, and the CIIMMS project

[1] The Nature Conservancy, 1998. "Framework for Water Quality Monitoring of the Kenai River."

wants to take advantage of this work that has already been done. Key aspects of these guidelines include:

- Guidelines incorporate required fields from FGDC (Federal Geographic Data Committee) Metadata Standards, while permitting usage of NBII biological metadata fields and optional FGDC fields. See *Content Standards for Digital Geospatial Metadata Workbook*[2] for details.
- Guidelines extend beyond geospatial data sets to address many other kinds of non-geospatial data and information that the Cook Inlet users hope to be able to access.
- Fields are organized to minimize data entry for non-geospatial information by using three successively comprehensive tiers of requirements: (level 1) fundamental bibliographic metadata for all information types, (level 2) specific fields for tabular data sets, and (level 3) comprehensive geospatial metadata for GIS related data layers.
- A controlled lexicon of watershed-related terms, local place and organizational names are used to limit the domain of subject, place, and source keywords, thereby simplifying the domain of field-specific search terms.

Metadata entry burdens might be minimized by considering another tier to the existing Chesapeake guidelines (i.e. level 0), that could be used by non-technical users to enter short references to non-geospatial information, like fact sheets, press releases, and the like.

The Chesapeake Bay existing metadata guidelines will be revised for Cook Inlet and posted to the CIIMMS website. The controlled lexicon for subject keywords will be simplified since such a complex system for keywords won't be required for the Cook Inlet basin. These subject keywords, data inventory classes, and other fields which have been built for the Chesapeake Bay will be modified to accommodate the data and information of Cook Inlet.

Step 6: Provide guidance and metadata assistance to CIIMMS' data providers

Using the CIIMMS web-accessible metadata entry tool, the project team and strategic members of the CIIMMS Advisory Group will provide metadata training, and metadata entry services where needed in order to populate the CIIMMS metadata database. Where metadata for geospatial datasets are created, they will be uploaded to the AGDC (Alaska Geospatial Data Clearinghouse) or ASGDC (Alaska State Geospatial Data Clearinghouse), whichever is deemed appropriate.

A considerable effort will be made by the CIIMMS project team to document even non-digital data, so that it may be made discoverable via CIIMMS. Guidelines will be provided, as well as technical assistance where necessary, to help make priority data sets accessible via CIIMMS.

Step 7. Expand number of distributed sites for access.

Primary and high priority datasets that are in compliance with documentation and process standards will be made accessible to the system. Other compatible datasets, accompanied by metadata files, will be linked to the system as time and budget constraints allow. Updates to

[2] 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.

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 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. Design, develop, and deploy visualization tools.

The objective of providing a set of visualization tools is to aid users in determining the usefulness of the data for a specific purpose. The current technology for visualization tools on the web is a moving target. Because the development of the prototype is driving the need and design specs for a visualization tool, it is difficult to define what technology will be used to build this functionality. Guidelines for tool design will include the following:

- the tool must be easy to use;
- it should take into account the very latest web technologies (i.e. distributed technologies);
- it should utilize/integrate current off-the-shelf products;
- it should be browser-based;
- user shouldn't have to download data to use the tool.

The visualization tool will be developed after the priority datasets, based on the user needs analysis and the CIIMMS prioritization scheme, and or/metadata have been made available through CIIMMS.

Step 9. Develop a long range implementation, training, and maintenance plan.

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, training, hardware and software, application and networking recommendations. Deliverables associated with Step 9 include CIIMMS System Documentation, Training Manual, and On-line User's Guide.

ADEC has committed to the long-term maintenance of the information management/monitoring system subsequent to completion of this project. To this end DEC has committed the following hardware and software resources to this project at a cost of $25,000. The CIIMMS Database Server will be a Compaq 2500 SQL Server with three 9 gigabyte SCSI Drives (RAID5) and 128 Megabytes of memory. The CIIMMS Internet Server will be a Compaq with three 4.5 gigabyte SCSI Drives (RAID5) and 128 Megabytes of memory. Both systems will be backed up nightly. The system will be housed at the Alaska Department of Environmental Conservation in Anchorage, Alaska. The operating system for the CIIMMS Database Server will be Windows NT. The CIMMS metadata database will be developed in Microsoft SQL Server 7.0. The Internet

Server will run Microsoft's Internet Information Server (IIS) on Windows NT. In addition to CIIMMS these servers may run additional ADEC processes.

The ADNR Commissioner has committed the agency to maintaining 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.

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 maintenance of the CIIMMS website and server, development and incorporation of DEC databases for access by CIIMMS, and water quality issues and database design (see Step 9, page 12). ADNR will lend assistance in the areas of geo-referenced data issues, visualization tools, and resource management issues.

ADEC will assist the technical contractor 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 has established a National Geospatial Data Clearinghouse node at the Alaska Department of Natural Resources. The "Alaska State Geospatial Clearinghouse" (ASGDC) has provided an electronic pathway to meet public and inter-agency demands for state and local geospatial data. Data is documented according to the FGDC requirements to ensure consistency and discovery on line. The ADNR Clearinghouse project focuses on and will complement the Alaska Geographic Data Clearinghouse (AGDC) site developed and maintained by USGS. (The CIIMMS search tools will access geospatial metadata from both clearinghouses.)

Alaska Department of Fish & Game will participate with the CIIMMS project in order to incorporate critical habitat areas, anadromous fish stream data, and the conversion of the regional guides for southcentral Alaska. Many of these datasets were identified during the User Needs Analysis Workshop as high priorities. Efforts to get ADFG data into a format that's compatible with public access via CIIMMS include metadata creation, data conversions, database updates and web accessibility. ADFG data that was published on the EVOS Research and Restoration CD-ROM, along with other EVOS data (seabirds, bald eagles, etc.) will be made accessible through the ADNR Alaska State Geospatial Data Clearinghouse.

As a member of the CIIMMS project team, US Geological Survey (USGS) will chair the CIIMMS Advisory Group, ensuring there is a bridge between technical, management, and end-

user concerns. They will provide technical and practical assistance in system design, implementation, and will help ensure that the system will remain usable in the future. USGS water databases are available, but are not currently retrievable via the web. If web accessibility to the water databases is deemed un-doable by the USGS (using their own servers and processes) within the CIIMMS funding and time constraints, USGS will tabulate commonly requested water information and/or data for web retrieval via CIIMMS.

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 and the CIIMMS Advisory Group involvement. EPA has also agreed to make all of its Water Quality and Permits databases available to the Cook Inlet Information 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 metadata database and structural framework for the eventual integration of water quality data, EVOS related data, environmental data, etc., into a web-accessible visualization tool. The technical consultant is key to the success of this project. We are working with EPA and will utilize Science Applications International Corporation (SAIC), 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 perform most data integration, application development, and user interface development. Where applications can be purchased off-the-shelf, CIIMMS will do so, in order to ensure that future upgrades to the system are automatic, and not dependent on the contractor. 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.

SCHEDULE

Initial Production Phase (Year 2)
Measurable Project Tasks for FY 2000 (October 1, 1999 -September 30, 2000)

October 1999	Evaluation of CIIMMS prototype continues. Refinement of prototype ongoing. (Step 1, page 8)
October 1999	Review of Preliminary System Specifications. (Step 2, page 8)
December 1999	Finalize System Specifications and Implementation Plan (Step 3, page 8)
January 2000	Implementation of Final System Specifications. Initiate integration of prioritized databases, related information and associated metadata; continue agency staff training as an ongoing evaluation tool. (Steps 4-8, pages 9-12)
August 2000	Access to specified databases completed. Data documentation (metadata) completed.
August 2000	Develop On-line User's Manual, Technical Specifications/System Documentation, including Long-Term Maintenance. (Step 9, page 12)
August 2000	Training and public outreach.
September 2000	Completion of Initial Production Phase of CIIMMS

Project Milestones and Endpoints

Initial Production Phase (Year 2)
(FY 99 October 1, 1999 to September 30, 2000)

October 1999	Schedule meeting of Cook Inlet Coalition/CIIMMS Advisory Group to present preliminary system specifications.
November 1999	Prototype Evaluation Comments Due.
December 1999	Final System Specifications and Implementation Plan Due.
July 2000	CIIMMS Water Quality Data Dictionary

August 2000	Integration/Access to databases, information and metadata, etc.
August 2000	On-line User's Manual and Technical Specifications/System Documentation (including long-term maintenance plan).
August 2000	Staff Training and Public Outreach.
September 2000	Completion of Initial Production Phase of CIIMMS

Completion Date September 30, 2000.

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 are not necessarily focused on watershed management. 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 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 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.

In the case of land managers responding to requests for permits in Cook Inlet tidelands, as required by statute, the CIIMMS would allow staff to access, and eventually view 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. CIIMMS could be used to direct permitting toward less sensitive areas.

Internet access to data and information 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 and even individuals in other government agencies to locate and access data and information even though the agencies are obligated to make this information available, i.e. FOIA requests.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

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, coordination with SEA, APEX and NVP, will avoid duplication of effort and ensure that pertinent data and information from those projects can be incorporated into this system.

A project being proposed for FY00 entitled "An Evaluation of the Data System for the Long Term Monitoring Program," will provide valuable background information for the CIIMMS project because web technology and web-based analysis tools are advancing at such a fantastic rate of speed. The collaboration of the CIIMMS project team with the principle investigators on the above mentioned project will be important.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

Based on results of the User Needs Analysis phase of CIIMMS, which included the January 1999 User Needs Workshop, the scope of this project has been narrowed to address more specific needs of Cook Inlet users with regard to *access* to data *and information*, as opposed to the actual *integration* of data.

The CIIMMS vision is to enable a wide-range of users (not just scientists and agency personnel) to share and access valuable information about the Cook Inlet watershed and Cook Inlet-related activities. Available information will range from primary data (geospatial, tabular) to reports, project descriptions, and other documents across a variety of themes, such as habitat, land-use, resource management, pollution, and water quality. CIIMMS will provide an interactive website for the Cook Inlet community to efficiently and effectively contribute, identify, and access relevant information from a distributed network of providers.

This process of accessing information and building a distributed network of data/information providers, via the web, is an iterative one. There is a plan, but the practice of adaptive management will be crucial to the success of CIIMMS. We must be open to user input, changes in technology, and able to alter, within reason, the specifications put forth in this document.

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 CIIMMS coordination within ADEC. He has served as the department representative to the Statewide GIS committee and Webmasters committee, and was responsible for the initial development of the ADEC website. 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.

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). 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.

Prior to her experience with ADNR, Ms Zeiner was employed for five years in the private sector and worked in business programming application development. Responsibilities related to programming included user needs analysis, systems design, coding, testing, and implementation of new and in-place applications.

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.

Leslie Patrick

Leslie Patrick has a MS in Science Management and BS in Geology from the University of Alaska. She has been employed in various capacities with the USGS since 1975. Many of her current responsibilities focus on ensuring that project planning and results adapt to modern technology while retaining scientific integrity. Her career experiences span scientific, technical, supervisory, administrative, and management functions. She has been categorized by titles such as project hydrologist, database manager, computer programmer, GIS specialist, systems analyst, project coordinator, operations manager, and facilitator. Whatever the actual function, she has served as a catalyst of change, moving from old processes to new.

KEY PERSONNEL

Greg Kellogg
Alaska Watershed Program Manager
US EPA, Alaska Watershed Program
222 W. 7th Ave., #19
Anchorage, AK 99513
Kellogg.Greg@EPAMAIL.EPA.GOV
Phone (907) 271-6328
Fax: (907) 271-6340

Lowell Suring
US Dept. of Agriculture
United States Forest Service
Chugach National Forest
3300 C Street, Suite 300
Anchorage, AK 99503

LITERATURE CITED

Alaska Department of Natural Resources. 1996. Proposed Oil and Gas Lease Sale 85A: Cook Inlet Exempt, Preliminary Finding of the Director. Alaska Department of Natural Resources, Division of Oil and Gas, Anchorage, AK.

Alaska Department of Natural Resources. 1995. Geographic Information Systems, Database Summary. Alaska Department of Natural Resources, Division of Support Services, Anchorage, AK.

Alaska Department of Natural Resources, National Oceanic and Atmospheric Administration. 1997. *Exxon Valdez* Oil Spill, Research and Restoration Information Project. Alaska Department of Natural Resources, Division of Support Services, Anchorage, AK

Alaska Department of Natural Resources. 1999. Alaska State Geospatial Data Clearinghouse. Alaska Department of Natural Resources, Division of Support Services, Anchorage, AK.

Exxon Valdez Oil Spill Trustee Council. Invitation to Submit Restoration Proposals for Federal Fiscal Year 2000. *Exxon Valdez* Oil Spill Restoration Office, Anchorage, AK.

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.

Michener, W.K. 1997. Quantitatively Evaluating Restoration Experiments: Research Design, Statistical Analysis, and Data Management Considerations. Restoration Ecology 5:324-337.

Minerals Management Service. 1996. Final Environmental Impact Statement for the Cook Inlet Planning Area Oil and Gas Lease Sale 149. U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region, Anchorage, AK.

Novotny, V. and H. Olem. 1994. Water quality: prevention, identification, and management of diffuse pollution. Van Nostrand Reinhold, New York.

Resource Data, Inc., 1997. Data Repository Analysis prepared for Alaska Department of Environmental Conservation, Anchorage, AK.

Samuels, W.B., J.G. Parker, W.N. Ganter, and G. Currey. 1997. Development of the Colorado Watershed Data Integration System. Science Applications International Corporation, McLean, VA.

Science Applications International Corporation. 1996. Chesapeake Bay Program Information Management Requirements and Recommendations. Science Applications International Corporation, McLean, VA.

Spies, R.B. 1997. Science and the Restoration Reserve. Memo to Molly McCammon. Applied Marine Sciences, Livermore, CA.

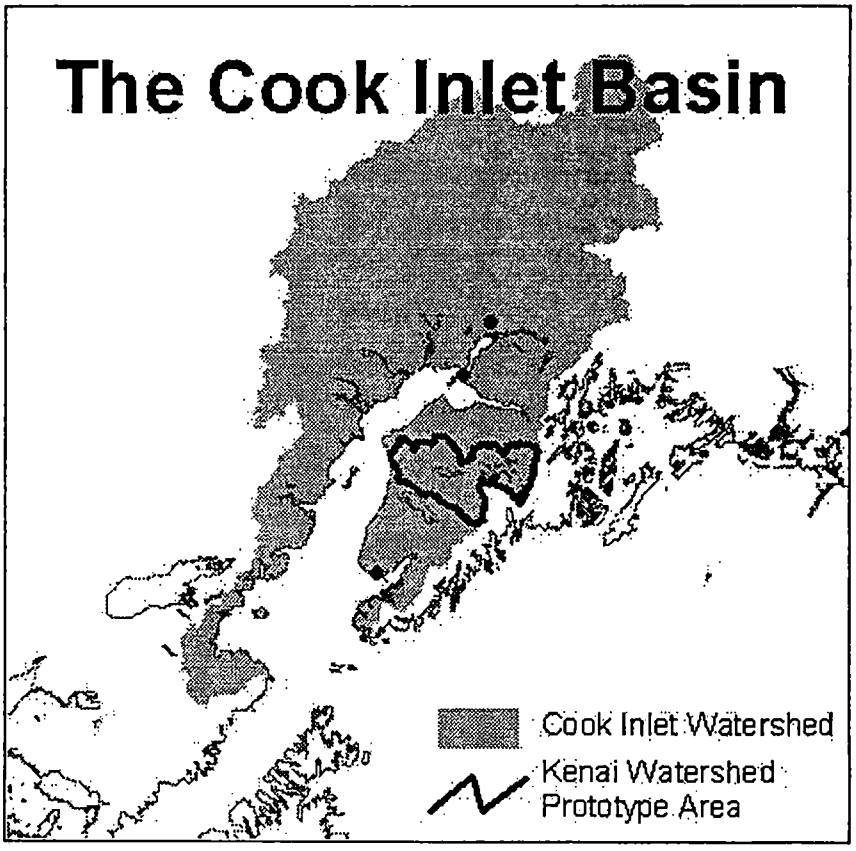
The Nature Conservancy, 1998. Framework for Water Quality Monitoring of the Kenai River.

U.S. Environmental Protection Agency. 1997. Designing an Information Management System for Watersheds. EPA841-R-97-005. Office of Water (4503F), United States Environmental Protection Agency, Washington, D.C.

U.S. Geological Survey. 1998. Alaska Geospatial Data Clearinghouse. U.S. Geological Survey, Anchorage, AK.

APPENDIX A
DESIGN SUMMARY FOR CIIMMS PROTOTYPE

Geographic Scope	Kenai River Watershed (see above map)
Information Types	Users' highest short-term priorities
Information Sources	ADEC, ADF&G, ADNR, Kenai Peninsula Borough Planning Department, USGS, and others
Functions	Users' short-term functional priorities and groundwork for medium-term functional priorities
Information Features	
-- *Identifying*	• Categorical indexes for Cook Inlet information inventory • Keyword and advanced metadata searching • Restoration project activities
-- *Accessing*	• Ability to view, download, and print static maps and web documents • Metadata records linked to actual data and summary information (e.g., fact sheets), data quality documentation • Hotlist of all related offsite links
-- *Contributing*	• Form for suggesting information and links to add to clearinghouse • Metadata entry tool to populate clearinghouse
Evaluation Tools	• User feedback form • Counters to track number of visits to each page



APPENDIX B
IN KIND CONTRIBUTIONS

DNR Secretarial and Administrative Support	3	117	$2,733.93
DNR Graphics Support (Contractual Amount)	1	28.5	$1,000.00
DNR LRIS Uncompensated Support	2	32.5	$3,380.00
Workshop Attendees	90	17	$61,200.00
EPA Staff	3	194	$10,599.08
EPA Contractual			$24,000.00
USGS Staff	1	25	$2,043.50
Briefings	104	3	$10,920.00
Interviews	30	3	$3,150.00
Questionnaires(require 2-8 hours to complete)	69	5	$12,075.00
DEC	5	131.8	$5,023.59
Travel			**$1,679.64**
Contractual			**$12.35**
Supplies			**$305.00**
Equipment			**$5,235.90**
Total Project Contributions as of March 1, 1999			**$143,357.99**

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000	PROPOSED FY 2000 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
			$214.0	$58.1	$449.2	$7.6	$65.2	
Personnel	$166.7	$369.1						
Travel	$4.0	$21.9						
Contractual	$130.0	$297.0						
Commodities	$0.2	$2.0						
Equipment	$0.0	$30.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$300.9	$720.0			Estimated FY 2001	Estimated FY 2002		
General Administration	$34.1	$74.1						
Project Total	$335.0	$794.1			$34.0	$0.0		
Full-time Equivalents (FTE)	0.0	5.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0			$0.0	$0.0		

Comments:

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Lead Agency: ADEC/ADNR

FORM 2A
MULTI-TRUSTEE
AGENCY
SUMMARY

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000						
Personnel	$74.4	$145.6						
Travel	$2.9	$16.6						
Contractual	$0.0	$6.0						
Commodities	$0.2	$0.5						
Equipment	$0.0	$23.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$77.5	$191.7			Estimated FY 2001	Estimated FY 2002		
General Administration	$11.2	$22.3						
Project Total	$88.7	$214.0			$9.0			
Full-time Equivalents (FTE)		2.4						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Environmental Conservation

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:
4/16/99

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
Jeff Hock	Environmental Specialist IV	20	2.0	7.2		14.4
Russell Kunibe	Analyst Programmer IV	20	12.0	6.9		82.8
TBD	Student Intern	12	12.0	2.3		27.6
Nadeem Siddiqui	SQL Database Administrator	22	1.0	7.4		7.4
TBD	IIS Server Manager	20	2.0	6.7		13.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		29.0	30.5	0.0	
					Personnel Total	$145.6

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
					0.0
Travel to Anchorage to work with cooperators and conduct training	0.5	12	36	0.2	13.2
Travel to Kenai to work with cooperators and conduct training	0.1	2	6	0.2	1.4
Travel to Homer to work with cooperators and conduct training	0.2	2	4	0.2	1.2
Travel to Mat-Su to work with cooperators and conduct training	0.0	2	4	0.2	0.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$16.6

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Environmental Conservation

FORM 3B
Personnel
& Travel
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
CIIMMS Z39.50 search engine maintenance	6.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$6.0

Commodities Costs:	Proposed
Description	FY 2000
Office Supplies (paper, toner cartridges, etc. for report preparation)	0.3
Computer support supplies (CD's, diskettes, cabling)	0.2
Commodities Total	$0.5

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Environmental Conservation

FORM 3B
Contractual & Commodities DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUS :OUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
Spatial Database Engine for DEC SQL Server	1	15.0	15.0
WEB Management Software	1	3.0	3.0
WEB Development Software (Graphics, FrontPage, Database Interface, PDF Creation)	1	2.5	2.5
WEB HTML search software	1	2.5	2.5
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$23.0

Existing Equipment Usage: Description		Number of Units	Inventory Agency
4 Computer Workstations with Software contributed by DEC,	$14,000		
DEC SQL Server w/Software, contributed by DEC	$15,000		
Laptop PC, contributed by DEC,	$3,500		
Internet WEB Server, contributed by DEC	$10,000		
Total DEC Equipment Contribution	$42,500		

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Environmental Conservation

FORM 3B
Equipment
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000						
Personnel	$86.0	$112.0						
Travel	$0.7	$4.1						
Contractual	$130.0	$291.0						
Commodities	$0.0	$0.0						
Equipment	$0.0	$7.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$216.7	$414.1			Estimated FY 2001	Estimated FY 2002		
General Administration	$22.0	$35.1						
Project Total	$238.7	$449.2			$15.0			
Full-time Equivalents (FTE)		1.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Natural Resources

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
	Analyst Programmer III	18	12.0	6.0		72.0
	Analyst Programmer IV	18	4.0	5.8		23.2
	Special Assistant	23	2.3	7.3		16.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		18.3	19.1	0.0	
					Personnel Total	$112.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
					0.0
Travel to Homer, Kenai, Soldotna	0.2	8	8	0.2	3.2
Travel to Juneau	0.5	1	2	0.2	0.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.1

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Natural Resources

FORM 3B
Personnel
& Travel
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

Contractual Costs:		Proposed
Description		FY 2000
Data Conversion, Cleanup, Documentation		12.0
Consulting Services for development and implementation of Final System Specifications		279.0
Develop final set of system specifications	$10.0	
Implementation of system specifications including refinement of CIIMMS interface	$50.0	
Metadata gateway, search tools	$9.0	
Access to distributed data systems, interface, and access tools.	$95.0	
Detailed plan for long term maintenance.	$40.0	
Development and deployment of visualization tools	$50.0	
Training manuals, system documentation, data dictionary	$25.0	
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$291.0

Commodities Costs:	Proposed
Description	FY 2000
Commodities Total	$0.0

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Natural Resources

FORM 3B
Contractual & Commodities DETAIL

Prepared:
4/16/99

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
			0.0
			0.0
Additional storage capacity for existing UNIX server	1	2.0	2.0
MetaManager Software	1	5.0	5.0
			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**	$7.0

Existing Equipment Usage: Description		Number of Units	Inventory Agency
DNR contribution of existing hardware, software, and other data management infrastructure with a value of:	$55.0		
2 Workstations, software, and peripherals	$10.0		
2 PCs and software	$6.0		
Total ADNR equipment contribution:	$71.0		

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Natural Resources

FORM 3B
Equipment
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$49.2						
Travel		$0.0						
Contractual		$0.0						
Commodities		$1.5						
Equipment		$0.0						
Subtotal	$0.0	$50.7			Estimated FY 2001	Estimated FY 2002		
General Administration		$7.4						
Project Total	$0.0	$58.1			$2.5			
Full-time Equivalents (FTE)		0.7						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Fish & Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:
4/16/99

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
	Cartographer	16	3.0	5.0		15.0
	Analyst Programmer	20	2.0	6.7		13.4
	Habitat Biologist	18	3.0	6.2		18.6
	Research Analyst II	16	0.5	4.3		2.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		8.5	22.2	0.0	
					Personnel Total	$49.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
					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

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Fish & Game

FORM 3B
Personnel
& Travel
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed FY 2000
Description	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed FY 2000
Description	
Network charges, database storage and transfer media, phone, fax, software upgrades	1.5
Commodities Total	$1.5

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Fish & Game

FORM 3B
Contractual & Commodities DETAIL

Prepared:
4/16/99

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
			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

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Fish & Game

FORM 3B
Equipment
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000	LONG RANGE FUNDING REQUIREMENTS					
Personnel	$6.3	$6.3						
Travel	$0.4	$0.4						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0						
Subtotal	$6.7	$6.7			Estimated FY 2001	Estimated FY 2002		
General Administration	$0.9	$0.9						
Project Total	$7.6	$7.6			$2.5			
Full-time Equivalents (FTE)		0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US Forest Service

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:
4/16/99

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
						0.0
Lowell Surring	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 2000
					0.0
Travel to Soldotna, Kenai, Homer	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
				Travel Total	$0.4

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US Forest Service

FORM 3B
Personnel
& Travel
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FY 2000
Commodities Total	$0.0

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US Forest Service

FORM 3B
Contractual & Commodities DETAIL

Prepared:
4/16/99

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
			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

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US Forest Service

FORM 3B
Equipment
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$56.0
Travel		$0.8
Contractual		$0.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$56.8
General Administration		$8.4
Project Total	$0.0	$65.2
Full-time Equivalents (FTE)		0.4
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		$5.0			

Dollar amounts are shown in thousands of dollars.

Comments:

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US DOI, USGS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:
4/16/99

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
						0.0
Leslie Patrick	Assistant District Chief, Water Resources Division					0.0
	Supervisory Hydrologist	13-6	5.0	11.2		56.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		5.0	11.2	0.0	
					Personnel Total	$56.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
					0.0
Travel to Homer, Kenai, Soldotna	0.2	2	2	0.2	0.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.8

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US DOI, USGS

FORM 3B
Personnel
& Travel
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed FY 2000
Description	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed FY 2000
Description	
Commodities Total	$0.0

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US DOI, USGS

FORM 3B
Contractual & Commodities DETAIL

Prepared:
4/16/99

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
			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

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US DOI, USGS

FORM 3B
Equipment
DETAIL

Prepared:
4/16/99

Growth Rates of Cutthroat Trout and Dolly Varden in Prince William Sound, Alaska: Comparison of Populations in Oiled and Unoiled Sites with Similar Geographic Features

Project Number: 00392

Restoration Category: Monitoring and Research

Proposer: USFS, Pacific Northwest Research Station

Lead Trustee Agency: USFS

Cooperating Agencies: Dept. of Fisheries and Wildlife, Oregon State University

Duration: 3 years

Cost FY 00: $159.4.

Cost FY 01: $214.0

Cost FY 02: $80.0

Geographic Area: Prince William Sound

Injured Resource/Service: Dolly Varden, Cutthroat Trout

ABSTRACT

Dolly Varden and cutthroat trout are listed as injured resources whose recovery is unknown. They were originally listed as injured because studies following the oil spilled found that growth rates of populations in oiled areas were less than those of populations in unoiled areas. We are proposing to examine growth rates of populations in oiled and unoiled areas by comparing sites with similar geographic features. Results from this study will determine the status of these species.

INTRODUCTION

Dolly Varden (*Salvelinus malma*) and cutthroat trout (*Oncorhynchus clarki clarki*) are important fish resources in Prince William Sound and are listed as injured resources whose recovery is unknown. These species were believed to be negatively impacted by the oil spill based on differences in growth rates between fish from oiled and unoiled sites. Recovery is assumed to occur when growth rates in oiled and unoiled areas, after considering geographic differences, are similar. Results from the our proposed work on comparison of growth rates will help determine if these species have recovered.

NEED FOR THE PROJECT

A. Statement of Problem

Dolly Varden and cutthroat trout are important ecological and recreational resources in Prince William Sound. Populations of each species are found throughout Prince William Sound (Mills 1988). There are resident and anadromous (i.e. sea-going) forms of each species. Anadromous individuals spend varying amounts of time in freshwater (up to 4 years) before going to the marine environment (Scott and Crossman 1979). There, both species feed in nearshore and estuary areas (Scott and Crossman 1979, Morrow 1980). Dolly Varden feed on crustaceans, small invertebrates, and fish (Armstrong 1971) and cutthroat feed on fish (Narver and Dahlberg 1965).

Areas used by these fish were impacted by petrogenic hydrocarbons from the *Exxon Valdez* oil spill. Benthic organisms in nearshore areas are particularly susceptible to petrogenic hydrocarbons (Teal and Howarth 1984). In Prince William Sound, the size of epifauna and numbers of amphipods, which are food sources for Dolly Varden, decreased in areas exposed to the spill (Jewett and Dean 1993, Jewett et al.1993). Hepler et al. (1993) found that Dolly Varden and cutthroat trout populations in oiled areas had slower growth rates compared to populations in unoiled streams from 1989 to 1990, the year of the spill. A similar pattern was observed for cutthroat trout in 1990 to 1991. However, growth rates of Dolly Varden in oiled areas did not differ from those in unoiled areas during that period (Hepler et al. 1993). Survival rates for each species from 1989 to 1990 were less in oil impacted areas than in unimpacted areas (Hepler et al. 1993). Hepler et al. (1993) hypothesized that chronic starvation and/or direct exposure to petrogenic hydrocarbons were responsible for the differences in growth and survival of the species in oiled and unoiled areas. The *Exxon Valdez* Oil Spill (EVOS) Trustee Council officially lists these species as injured resources whose recovery is unknown.

B. Rationale/Link to Restoration

Reduced growth and survival rates could have long-term impacts on populations of Dolly Varden and cutthroat trout in areas exposed to oil. These species may live up to 8 years (Morrow 1980) and the expected persistence of oil in the nearshore environment (Lee et al. 1979) suggests the

potential exists for long-term impacts to these species. Decreased survival would have obvious population implications. The extent would depend on population size; smaller populations would be most susceptible to eventual extinction (Rieman et al. 1993). There may be less obvious impacts also. Potential for loss of genetic variability, which is needed for long term adaptation, increases as population size decreases (Nelson and Soule 1987). Reduced growth rates of individuals can lead to increased susceptibility to mortality and decreased reproductive potential (Adams 1990). If any of these impacts were to occur for extended periods, even at low levels, affected populations would face increased probability of extinction.

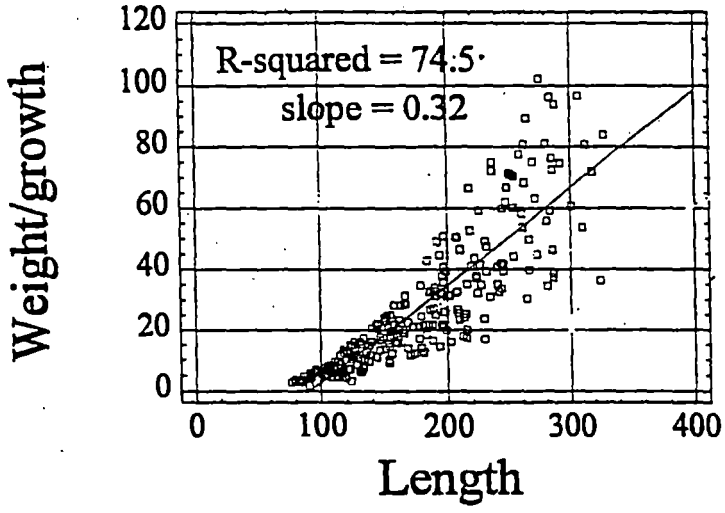
Initial assessments of the oil spill effects suggested that Dolly Varden and cutthroat trout populations in oiled areas were negatively affected. Original damage determinations were made by comparing populations in unoiled sites at Makaka Creek and Boswell Bay (Hitchenbrook Island) in eastern PWS with populations in oiled areas at Rocky Bay (Montegue Island), Green Island, and Eschamy Bay. The latter two are in western PWS. Hepler et al. (1993) found that populations of both fish in oiled areas had slower growth rates from 1989 to 1990 than populations in unoiled areas. Similar results were found for cutthroat trout from 1990 to 1991 (Hepler et al. 1993). Growth rates of Dolly Varden were similar during the same period, however. No formal studies of growth have been conducted since then.

The general criteria for recovery was that growth rates of each species in oiled areas will be the same as that in unoiled areas. Recently, the criteria was amended so that variation related to geographic differences among areas must be considered.

We collected Dolly Varden and cutthroat trout in FY 96 and 97 from sites throughout PWS as part of Project 97145, which is examining relations among populations of these species. We have made some preliminary examinations of otoliths from cutthroat trout in unoiled sites in different parts of PWS to determine growth rates. We compared growth rates of fish from eastern PWS with those of fish from western PWS (Fig. 1). Slopes of the relation between size and age are different for the two areas. Fish from eastern PWS grow at a faster rate than those from western PWS. A closer examination of fish from comparable sites is shown in Fig. 2. Fish from Milton Lake (eastern PWS) were consistently larger at a given age compared to fish from Unakwik Inlet (western PWS). These preliminary results suggest that conditions for growth are better in eastern PWS and simply comparing growth rates of populations in oiled and unoiled sites may not be appropriate.

Determination of growth rates was not an objective of the original proposal for Project 97145. We initiated examination of growth rates after working in PWS for two summers (FY 96 and 97). We observed wide variation in conditions across PWS that believed that this could influence growth rates. Eastern PWS has more well developed intertidal areas than western PWS. Intertidal areas in eastern PWS are also shallower and more extensive than those in western PWS. Environmental conditions that influence growth appear to be more favorable in eastern PWS. The growing season in western PWS is 4-6 shorter than that in eastern PWS (K. Holbrook, US Forest Service, Anchorage, AK). Air temperatures are also cooler in western PWS.

A. Prince William Sound- Eastside



B. Prince William Sound- Westside

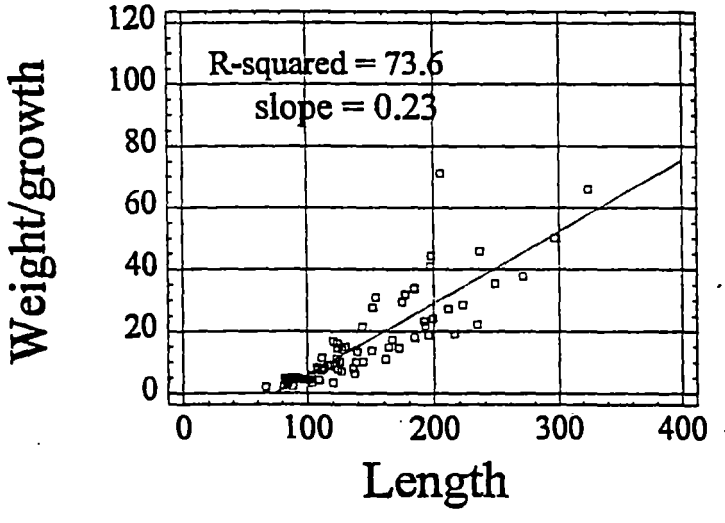


Fig. 1. Estimated growth rates of cutthroat trout from unoiled sites in eastern (A) and western (B) Prince William Sound. Growth rates are from otoliths. Fish were collected in FY 96 as part of Project 97145.

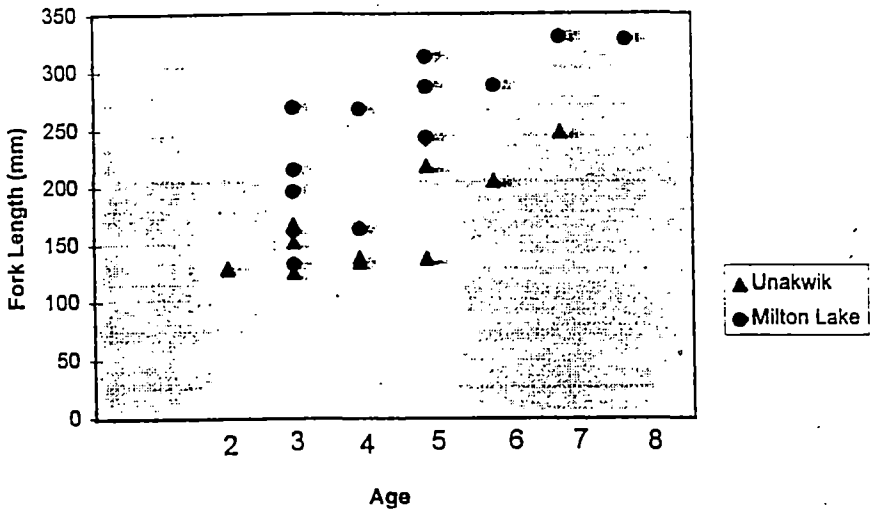


Fig. 2. Comparison of estimated size at age of cutthroat trout from Milton Lake (eastern Prince William Sound) and Unakwik Inlet (western Prince William Sound). Both sites are unoiled. Growth rates are from otoliths. Fish were collected in FY 96 as part of Project 97145.

These results are preliminary and should not be construed that growth rates are actually different between eastern and western PWS. These data have limitations. A primary one is that we did not have individuals from all age/size classes in a population. Project 97145 focused collection efforts in intertidal areas and lower portions of watersheds. Consequently, few small, younger-aged fish were collected. A valid comparison of growth rates must include all age-classes.

C. Location

This study will examine sites located throughout Prince William Sound. Benefits should be realized in communities throughout Prince William Sound.

COMMUNITY INVOLVEMENT

We quartered out of Cordova, AK for field collections in Project 97145 and will continue to do so for this study. Cordova provided a central location from which to access study sites, had good facilities, and allowed us access to additional field equipment and persons with knowledge of streams in Prince William Sound. We will continue to communicate with people in Cordova on an individual basis about our work and will make presentations on results when they become available. We will charter planes and boats for transport to field locations, secure lodging, and purchase food and other supplies in Cordova in FY00 if the proposal is funded.

PROJECT DESIGN

A. Objectives

The objective of this proposed study is to:

1. Determine growth rates of Dolly Varden and cutthroat trout in oiled and unoiled areas with similar geographic features based on analysis of otoliths.

We will test the following hypotheses:

1. Populations of each species from oiled and unoiled areas with similar geographic features have similar growth rates.

B. Methods

In order to distinguish between differential and equal growth rates in fish from "oiled" and "un-oiled" areas, it is necessary to distinguish 1) marine growth from freshwater growth and 2) to be able to measure growth over a standard time interval. Our approach is to use sagittal otoliths as an internal "record collector" of an individual's prior environmental history and its prior growth rate.

Marine growth

Elemental concentrations in otoliths have been shown to vary with numerous environmental variables including temperature (Radtke, 1989; Townsend et al., 1995), salinity (Secor et al., 1995), water chemistry (Mugiya et al., 1991) and significant life history events such as the migration from freshwater to marine environments (et al., 1996; Secor and Piccoli, 1996). Elemental concentrations also vary with ontogenetic variables such as size or age (Edmonds et al., 1992; Hoff and Fuiman, 1993; Campana and Gagne, 1994) and growth rate (Kalish, 1989; Sadovy and Severin, 1992, 1994). In addition, genotype may influence elemental concentrations, as levels at the otolith core can differ between fish from distinct geographic regions (Campana and Gagne, 1994; Thresher et al., 1994) or between anadromous and resident salmonids (Kalish, 1990). These studies suggest that in general:

$$C_{oncentration} = E_{nvironment} + O_{ntogeny} + G_{enotype} + \mathbf{0}_{rror},$$

that is, the concentration of an element in the otolith is dependent upon the combined influences of environment, ontogeny, genotype, and error. The relative importance of these four factors is likely to vary among elements and among species. Because several factors may influence otolith composition, interpretation of natural variation can be difficult.

Natural variation in element concentrations has been interpreted primarily in two ways. Variation along a transect from otolith core to margin has been interpreted as a record of environmental experience in temperature (Radtke et al. 1989; Townsend et al. 1995) and salinity (Radtke et al. 1996; Secor and Piccoli, 1996). Differences among individuals have been used to infer stock or population structure (Mulligan et al., 1987; Edmonds et al., 1989, 1992; Campana and Gagne, 1994; Campana et al., 1994). Because this study also includes a measure of genetic relatedness (see above), as well as age, transect variation in otolith composition could be a useful approach for studying movements of migratory anadromous salmonids.

We propose to compare natural variation in element concentration with age, genetics (stock origin) and environmental conditions at time of capture. We assume that otolith element concentrations at the edge of the otolith were deposited under the environmental conditions at capture and that the correlation of core concentrations to edge concentrations reflect the individual's inherent physiological/genetic bias to deposit that element. Consequently, it will be important to 1) sample individuals in different habitats, 2) establish relative changes within an individual and 3) to corroborate signals with other evidence such as genetics and age information. Although we expect strontium to be the best indicator of marine residence (Kalish, 1990), our study will independently demonstrate which elements are good indicators of marine residence. Transects across the otolith will then help reconstruct a picture of marine and freshwater residence of an individual.

Growth and age

If successful, otolith element concentration can distinguish the relative proportion of the otolith produced in freshwater from that produced in salt water. In general, faster growing fish produce

larger rings, but body growth does not necessarily show a linear relationship with otolith growth (Mosegaard et al. 1988, Bradford and Geen, 1992). For this study, we must be able to partition growth as well as time. We need to know 1) how long a fish has been in the marine environment and 2) how well it grew. For this study we will compare "oiled" and "un-oiled" fish hierarchically. Genetically similar fish (same stock) of the same age found in both areas constitute the most powerful comparison, followed by similar age/ different stocks and different age/similar stocks, followed by all fish combined. We will assume that sub-annular marks are non-randomly deposited and the number of sub-annular marks measures time in the marine environment. Differential growth in the "oiled" and "un-oiled" areas will be measured as otolith dimension (radius or area) produced in saltwater normalized by time in salt water.

Proposed Work Plan

Growth documentation: Samples must be collected in fresh water and in salt water. In both cases the timing of collections should be such that specimens collected are likely to have been in the habitat for several months. Saltwater collections will be made in July, 2000 and freshwater in September, 2000. A minimum of 50-60 specimens per site per year will be collected for this purpose and "edge analysis" of otolith microchemistry will be used to evaluate the concordance of otolith chemical signals and habitat at capture. Specimens will be approximately half adults and half juveniles.

Differential growth: Microchemistry transect analyses will be used to identify the most recent portion of the otolith that was deposited in a marine environment. We will assume that fish in the "oiled" area did not spend time in the "un-oiled" area. Differential growth will be evaluated as time normalized otolith growth in the marine environment. We will make paired comparisons of each oiled site (e.g., Bay of Isles (Knight Island), Green Island, and Eschamy Bay) with a nearby unoiled site. We will also determine growth rates from an unoiled sites in eastern PWS that were used as controls in the initial assessment by ADFG.

Study limitations

Unvalidated time measurement. We assume that sub-annular marks are deposited non-randomly and have a temporal component. If there is individual variation in deposition rate and if there is a bias with that variation and presence in "oiled" or "un-oiled" areas, our results will be spurious. We expect to find individual variation but we do not expect to find that variation correlated with marine habitat.
Spurious environmental correlation. Otolith size - fish size relationships have an important temperature component (Mosegaard et al,, 1988). If temperature regimes in "oiled" and "un-oiled" areas differ significantly, the metabolic signal associated with higher temperature in otolith deposition will mask growth differences.

Prior to initiation of the study it is not possible to determine the level of differences we might be able to detect. Small effects of 5-10% are unlikely to be detected whereas order of magnitude effects are highly likely to be detected.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

We will develop a cooperative agreement with the Dept. of Fisheries and Wildlife, Oregon State University (OSU), Corvallis, OR to complete growth analysis. We will pursue this avenue to save overhead costs. If the EVOS Trustee Council were to contract the grant directly to the university, overhead would be approximately 40%. The USFS has a cooperative agreement with the university that charges 8% for overhead. The growth laboratory at OSU has been involved in numerous studies involving a variety of salmonids for several years.

We will need obtain a permit from ADFG to collect fish if the growth proposal is funded. Scientific studies of a limited nature, such as this one, can be exempted from NEPA requirements. We will persue this exemption by filing a Catagorical Exclusion. This document will be prepared by the USFS, Cordova District in FY00, as they did in FY96 and FY97 for Project 97145.

SCHEDULE

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

October 1999:	Develop cooperative agreement with OSU
November - December 1999:	Identification of potential field sites Application for collection permit from ADFG
March 2000:	Secure charter vessel for field sampling Assemble required field gear and ship to Cordova
March - : June 2000	Preliminary analysis of otolith from previously collected fish Development of analysis protocols
July 2000:	Collection of cutthroat adults in saltwater and juveniles in freshwater
August 2000:	Initiate analysis of fish collected in July
September 2000:	Collect samples of Dolly Varden adults in freshwater Prepare progress report

B. Project Milestones and Endpoints

Major tasks and dates over the projected duration of the study are as follows:

July and September 2000:	Collect samples
March 2001:	Report Initial Analysis

July and September 2001:	Collect second year samples
May 2002:	Present preliminary results
September 2002:	Present final results and report Submit papers on results to peer-reviewed journals

C. Completion Date

This project is scheduled to be completed in FY02 At that time, we will provide information on the growth rates of each species and determine if recovery has occurred.

PUBLICATIONS AND REPORTS

It is unlikely that we will be preparing or submitting any manuscripts to peer-reviewed journals until the study is completed in FY02.

PROFESSIONAL CONFERENCES

Because data collection and analysis will be incomplete, we do not plan to make any presentations on results from the study until FY02.

NORMAL AGENCY MANAGEMENT

Determination of growth rates of fish is generally not required by statute or regulation for management responsibilities of the USDA Forest Service. Consequently, the agency does not normally fund this type of research, even though it may be valuable in planning and development of management programs. For this study, the USFS is contributing the salary of one of the principal investigators (G. H. Reeves), and assistance with lab work.

There will be no additional injury to Dolly Varden and cutthroat trout populations from the oil spill itself if this study is not funded. However, the status of these species is currently unknown. This study will provide that information. While this project has application in applied and basic science arenas, it is not clear what agency or organization would be interested in funding this project or one like it in the near future.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

We will coordinate with ADFG and USFS to identify sampling sites and will review the sites before sampling begins in FY00 to insure that we do not impose unnecessary damage on any population. We had arrangements with the USFS, Cordova Ranger District, for use of boats and other equipment in Project 97145 and expect that would happen with this study. We are not aware of any comparable study that ADFG has or plans at present.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This is a new proposal that has grown out of Project 97145.

PROPOSED PRINCIPAL INVESTIGATORS

Gordon H. Reeves
USFS Pacific Northwest Research Station
Corvallis, OR 97331
541-750-7314
541-750-7329
reevesg@fsl.orst.edu

Douglas F. Markle
Dept. of Fisheries and Wildlife
Oregon State University
Corvallis, OR 97331

541-737-1970
541-737-3590

PERSONNEL

The core personnel for this proposal are eminently qualified to implement this project. Gordon H. Reeves, Co-principal Investigator, is a research fish biologist with the USFS, Pacific Northwest Research Station, Corvallis, OR. He has been in that capacity for 10 years and has worked on anadromous salmonids research in streams throughout the Pacific Northwest and southeast Alaska. He has been involved with the development of conservation and restoration for anadromous salmonids in the Pacific Northwest. He is currently directing a study that is determining the relation of coastal cutthroat trout populations throughout their distributional range. He has published several articles on the ecology of anadromous salmonids and their freshwater habitat in peer-reviewed journals.

Douglas F. Markle, would be the Co-principal Investigator if the new objective is funded. Dr. Markle is currently a professor in the Dept. of Fisheries and Wildlife, Oregon State University. He has been involved with numerous studies of life-histories and growth of a wide variety of marine and freshwater fishes. He has done some of the most cutting-edge work on otolith and growth and has published several articles on the subject. He will supervise the growth comparison objective of this study.

Brief resumes for each of these individuals follow.

GORDON H. REEVES
USDA Forest Service, Pacific Northwest Research Station, Oregon State University, Corvallis, OR 97331.

Education:
B.A. - Biology, State University of New York, Oswego. 1973.
M.S. - Fisheries Science, Humboldt State University. 1978.
Ph.D. - Fisheries Science, Oregon State University. 1985.

Experience:
Assistant Professor, Department of Fisheries and Wildlife, Oregon State University. 1987 to present.
Courtesy Assistant Professor, Department of Fisheries. Humboldt StateUniversity. 1986 to present.
Research Fishery Biologist, USDA Forest Service, Pacific Northwest Forest and Range Experiment Station. 1986 to present.
Commercial Fisherman, Trinidad , California. 1978-79.
Research Biologist, New York State Research Foundation. State University of New York, Oswego. 1973-1976.

Professional Societies:
American Fisheries Society, North American Benthological Society. Sigma Xi National Honor Society

Professional Activities:
President, Oregon Chapter of the American Fisheries Society. 1989.
President-elect, Oregon Chapter of the American Fisheries Society. 1988.

Honors and Awards:
Certificate of Merit, USDA Forest Service. 1984
Certificate of Merit and Quality Step Increase, USDA Forest Service. 1986, 1989, and 1994.
Ethics in Science Award, USDA Forest Service. 1989.
Oldfield Team Award, College of Agriculture, Oregon State University. Award given for outstanding research by the Stream Team. 1991.
USDA Forest Service Rise to the Future Award for outstanding contributions in fishery research. 1991.

Conservationist of the Year Award, Pacific Rivers Council. 1992 and 1994.
USDA Secretary's Award for outstanding contribution to research contributing to understanding of aquatic ecosystems. 1995.

Special Assignments
Member Scientific Panel on Late-Successional Forest Ecosystem - formed by the Agriculture Committee and the Merchant Marine and Fisheries Committee of the U.S. House of Representatives to develop and evaluate alternatives for managing and conserving late-successional forest and aquatic ecosystems on federal lands in northern California and western Oregon and Washington. 1991.
Co-Leader PacFish Team - responsible for developing and evaluating alternatives for managing freshwater habitat of anadromous salmonids on federal lands in northern California, Oregon, Washington, Idaho, and Alaska. 1992-1993.
Member Scientific Assessment Team - develop management strategy for maintaining biodiversity of federal lands in northern California and western Oregon and Washington at request of U.S. Federal Circuit Court Judge. 1992.
Co-leader of Aquatic Group of Forest Ecosystem Management and Assessment Team -responsible for developing and evaluating alternatives for managing federal lands in northern California and western Oregon and Washington. 1993.

Selected Publications
Reeves, G. H., F. H. Everest, and J. D. Hall. 1987. Influence of water temperature on interactions between the redside shiner (*Richardsonius balteatus*) and the steelhead trout (*Salmo gairdneri*). Canadian Journal of Fisheries and Aquatic Sciences 44:1603-1613.
Hankin, D. G. and G. H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fisheries and Aquatic Sciences 45:833-844.
Dolloff, C. A. and G. H. Reeves. 1990. Microhabitat partitioning among stream-dwelling juvenile coho salmon, *Oncorhynchus kisutch*, and Dolly Varden, *Salvelinus malma*. Canadian Journal of Fisheries and Aquatic Sciences 47:2297-2306.
Sedell, J. R., G. H. Reeves, F. R. Hauer, J. A. Stanford, and C. P. Hawkins. 1990. Role of refugia in recovery from disturbances: modern fragmented and disconnected river systems. Environmental Management 14:711-724.
Reeves, G. H., J. D. Hall, T. D. Roelofs, C. O. Baker, and T. Hickman. 1991. Habitat enhancement and rehabilitation for anadromous salmonids. Pages 519-557. American Fisheries Society Publication No. 19.
Bisson, P. A., T. P.Quinn, G. H. Reeves, and S. V. Gregory. 1992. Best management practices, cumulative effects, and long-term trends in fish abundance in Pacific Northwest river systems. Pages 189-232. in R.J. Naiman, editor. Watershed management: balancing sustainability and environmental change. Springer-Verlag, New York.
Reeves, G. H. and J. R. Sedell. 1992. An ecosystem approach to the conservation and management of freshwater habitat for anadromous salmonids in the Pacific Northwest. Transactions of the 57th North American Wildlife and Natural Resources Conference 1992:408-415.

Thomas, J. W. , G. H. Reeves, and others. 1993. Viability assessments and management considerations for species associated with late-successional and old-growth forests of the Pacific Northwest: the report of the Scientific Analysis Team. USDA Forest Service, Portland, OR 530 p.

Reeves, G. H., F. H. Everest, and J. R. Sedell. 1993. Diversity of juvenile anadromous salmonid assemblages in basins in coastal Oregon with different levels of timber harvest activities. Transactions of the American Fisheries Society 122:309-317.

Thomas, J. W., G. H. Reeves, and others. 1993. Forest ecosystem management: an ecological, economic, and social assessment. Report of the Forest Ecosystem Management Assessment Team. USDA Forest Service, Portland, OR

Hicks, B. J. and G. H. Reeves. 1994. Restoration of stream habitat for fish using in-stream structures. Pages 67-92. in K. J. Collier, editor. Restoration of aquatic habitats. Selected papers from the second day of the New Zealand Limnological Society 1993 Annual Conference. New Zealand Department of Conservation, Wellington, New Zealand.

Reeves, G. H., L. E. Benda, P. A. Bisson, and J. R. Sedell. 1995. A disturbance-based ecosystem approach to maintaining and restoring freshwater habitats of evolutionary significant units of anadromous salmonids in the Pacific Northwest. Pages 334-349. *in* J. L. Nielsen, ed. Evolution and the aquatic ecosytem: defining unique units in population conservation. American Fisheries Society Symposium 17.

DOUGLAS F. MARKLE
Dept. of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331

Education
Ph.D. College of William and Mary (1976).
M.S. College of William and Mary (1972).
B.S. Cornell University (1969).

Experience
Professor, Oregon State University (1991-present)
Associate Professor, Oregon State University (1985-1991)
Research Scientist, Huntsman Marine Laboratory, Canada (1977-1985)
Research Assistant, Virginia Institute of Marine Science (1973-1977)
Marine Scientist, Virginia Institute of Marine Science (1971-1972).

Professional Service
American Society of Ichthyologists and Herpetologists, Editorial Board member, 1987, 1989-present; Board of Governors, member, 1990-1994.
The American Fisheries Society, Associate Editor of Early Life History Section, 1988-1990.

Selected Publications
Toole, C. L., D. F. Markle and C. J. Donohoe, in press. Settlement timing, distribution and

abundance of Dover sole (Microstomus pacificus) on an outer continental shelf nursery area. Can. J. Fish. Aquat. Sci.

Markle, D. F. and D. C. Simon, in press. Numerical dominance and origin of exotic fathead minnows in Upper Klamath Lake, Oregon. N. Amer. J. Fish. Management.

Melendez, R. C. and D. F. Markle, in press. Phylogeny and zoogeography of Laemonema and Guttigadus (Pisces; Gadiformes; Moridae). Bull. Mar. Sci.

Markle, D. F., in press. Audubon's hoax: Ohio River fish described by Rafinesque. Archives of Natural History.

Logan, D., E. L. Bibles, and D. F. Markle, 1996. Recent collections of exotic aquarium fishes in the freshwaters of Oregon and thermal tolerance of oriental weatherfish and pirapatinga. Calif. Fish Game 82:66-80.

Markle, D. F. and Y. I. Sazonov, 1996. Review of the rare deep-sea fish genus, Aulastomatomorpha (Teleostei: Salmoniformes), with a discussion of relationships. Copeia.

Lattin, J. D., A. Liston and D. F. Markle. 1995. Systematic collections at Oregon State University. Association of Systematics Collections Newsletter.

Toole, C.L., D.F. Markle and P.M. Harris, 1993. Relationships between otolith microstructure and early life history events in Dover sole, Microstomus pacificus. U. S. Fish. Bull., 91:732-753.

Toole, C.L., D.F. Markle and P.M. Harris, 1993. Relationships between otolith microstructure and early life history events in Dover sole, Microstomus pacificus. U. S. Fish. Bull., 91:732-753.

Miya, M. and D. F. Markle, 1993. Bajacalifornia aequatoris, a new species of alepocephalid fish (Pisces: Salmoniformews) from the Central Equatorial Pacific. Copeia, 1993:743-747.

Markle, D.F., P.M. Harris and C. L. Toole, 1992. Metamorphosis and an overview of early-life-history stages in Dover sole (Microstomus pacificus). U. S. Fish. Bull. 90:285-301.

Markle, D. F., T. N. Pearsons and D. T. Bills, 1991. Natural history of Oregonichthys (Pices: Cyprinidae) with a description of a new species from the Umpqua River of Oregon. Copeia, 1991 (2): 277-293.

LITERATURE CITED

Adams, S. M. 1990. Status and use of biological indicators for evaluating the effects of stress on fish. Pages 1-8. *in* S. M. Adams, editor. Biological indicators of stress in fish. Symposium 8, American Fisheries Society.

Bradford, M, J, and G. H. Geen, 1992. Growth estimates from otolith increment widths of juvenile chinooksalmon (Oncorhynchus tshawytscha) reared in changing environments. J. Fish Biol. 41:825-832.

Campana, S. E., and J. A. Gagne. 1994. Cod stock discrimination using ICPMS elemental assays of otoliths. *In* D. H. Secor, J. M. Dean, and S. E. Campana, (eds.), Recent developments in fish otolith research. University of South Carolina Press, Columbia, S.C.

Campana, S. E., A. J. Fowler, and C. M. Jones. 1994. Otolith elemental fingerprinting for stock identification of Atlantic cod (*Gadus morhua*) using laser ablation ICPMS. Can. J. Fish. Aquat. Sci. 51:1942-1950.

Edmonds, J. S., M. J. Moran, and N. Caputi. 1989. Trace element analysis of fish sagittae as an aid to

stock identification: pink snapper (*Chrysophrys auratus*) in western Austrailian waters. Can. J. Fish. Aquat. Sci. 46:50-54.

Edmonds, J. S., R. C. J. Lenanton, N. Caputi, and M. Morita. 1992. Trace elements in the otoliths of yellow-eye mullet (*Aldrichetta forsteri*) as an aid to stock identification. Fish. Res. 13:39-51.

Hepler, K. R., P. A. Hansen, and D. R. Bernard. 1993. Impact of oil Spilled from the *Exxon Valdez* on survival and growth of Dolly Varden and cutthroat trout in Prince William Sound. Alaska Department of Fish and Game, Division of Oil Spill Assessment and Restoration, Anchorage, Alaska. 38 pages.

Hoff, G. R., and L. A. Fuiman. 1993. Morphometry and compostion of red drum otoliths: changes associated with temperature, somatic growth rate, and age. Comp. Biochem. Physiol. 106A:209-219.

Jewett, S.C. and T. A. Dean. 1993. The effects of the *Exxon Valdez* oil spill on infaunal invertebrates in the eelgrass habitat of Prince William Sound. Paper presented at the Exxon Valdez Oil Spill Symposium, 2-5 February, 1993. Anchorage, Alaska.

Jewett, S.C., T. A. Dean, and D. R. Laur. 1993. The effects of the *Exxon Valdez* on benthic invertebrates in silled fjords in Prince William Sound. Paper presented at the Exxon Valdez Oil Spill Symposium, 2-5 February, 1993. Anchorage, Alaska.

Kalish, J. M. 1989. Otolith microchemistry: validation of the effects of physiology, age and environment on otolith composition. J. Exp. Mar. Biol. Ecol. 132:151-178.

Kalish, J. M. 1990. Use of otolith microchemistry to distinguish progeny of sympatric anadromous and non-anadromous salmonids. Fish. Bull. 88:657-666.

Kalish, J. M. 1992. Formation of stress-induced chemical check in fish otoliths. J. Exp. Mar. Biol. Ecol. 162:265-277.

Lee, R. F., S. C. Singer, K. R. Tenore, W.S. Gardner, and R. M. Philpot. 1979. Detoxification system in polychaete worms: importance in the degradation of sediment hydrocarbons. Pages 23-37. *in* W. B. Vernberg, F. P. Thurburg, A. Calabrese, and F. J. Vernberg, editors. Marine pollution: functional responses. Academic Press, New York.

Mills, M. J. 1988. Alaska statewide sport fisheries harvest report. Alaska Department of Fish and Game, Fishery Data Series No. 2.

Morrow, J. E. 1980. The freshwater fishes of Alaska. Alaska Northwest Publishing Co., Anchorage, Alaska. 248 pages.

Mosegaard, H., H. Svedang, and K. Taberman, 1988. Uncoupling of somatic and otolith growth rates in Arctic char (*Salvelinus alpinus*) as an effect of differences in temperature response. Can. J. Fish. Aquat. Sci., 45:1514-1524.

Mulligan, T. J., F. D. Martin, R. A. Smucker, and D. A. Wright. 1987. A method of stock identification based on the elemental composition of striped bass *Morone saxatilis* (Walbaum) otoliths. J. Exp. Mar. Biol. Ecol. 114:241-248.

Narver, D. W. and M. L. Dahlberg. 1965. Estuarine food of Dolly Varden at Chignak, Alaska. Transactions of the American Fisheries Society 94:405-408.

Nelson, K. and M. E. Soule. 1987. Genetical conservation of exploited fishes. Pages 345-368. *in* N. Ryman and F. Utter, editors. University of Washington Press, Seattle, Washington.

Radtke, R.L. 1989. Strontium-calcium concentration ratios in fish otoliths as environmental indicators. Comparative Biochemistry and Physiology 92A:189-193.

Radtke, R., M. Svenning, D. Malone, A. Klementsen, J. Ruzicka, and D. Fey. 1996. Migrations in an extreme northern population of Arctic charr *Salvelinus alpinus*: insights from otolith microchemistry. Mar. Ecol. Prog. Ser. 136:13-23.

Rieman, B., D. Lee, J. McIntrye, K. Overton, and R. Thurow. 1993. Consideration of extinction risks for salmonids. FHR Currents. Fish Habitat Relationships Technical Bulletin, Number 14, December 1993. U.S. Government Printing Office. 1993-583-068.

Sadovy, Y., and K. P. Severin. 1992. Trace elements in biogenic aragonite: correlation of body growth rate and strontium levels in the otoliths of white grunt, *Haemulon plumier* (Pisces:Haemulidae). Bull. Mar. Sci. 50:237-257.

Sadovy, Y., and K. P. Severin. 1994. Elemental patterns in red hind (*Epinephelus guttatus*) otoliths from Bermuda and Puerto Rico reflect growth rate, not temperature. Can. J. Fish. Aquat. Sci. 51:133-141.

Scott, W. B. and E. J. Crossman. 1979. Freshwater fishes of Canada. Fisheries Research Board of Canada, Bulletin Number 184. 966 pages.

Secor, D. H., A. Henderson-Arzapalo, and P. M. Piccoli. 1995. Can otolith microchemistry chart patterns of migration and habitat utilization in anadromous fishes? J. Exp. Mar. Biol. Ecol. 192:15-23.

Secor, D. H., and P. M. Piccoli. 1996. Age- and sex-dependent migrations of striped bass in the Hudson River as determined by chemical microanalysis of otoliths. Estuaries 19:778-793.

Teal, J. M. and R. W. Howarth. 1984. Oil spill studies: a review of ecological effects. Environmental Management 8:27-44.

Thresher, R. E., C. H. Proctor, J. S. Gunn, and I. R. Harrowfield. 1994. An evaluation of electron-probe microanalysis of otoliths for stock delineation and identification of nursery areas in a southern temperate groundfish, *Nemadactylus macropterus* (Cheilodactylidae). Fish. Bull. 92:817-840

Townsend, D. W., R. L. Radtke, D. P. Malone, and J. P. Wallinga. 1995. Use of otolith strontium:calcium ratios for hindcasting larval cod *Gadus morhua* distributions relative to water masses on Georges Bank. Mar. Ecol. Prog. Ser. 119:37-44.

2000 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$61.2
Travel		$16.0
Contractual		$66.8
Commodities		$1.5
Equipment		$0.0
Subtotal	$0.0	$145.5
General Administration		$13.9
Project Total	$0.0	$159.4
Full-time Equivalents (FTE)		1.5

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		$214.0	$80.0		

Dollar amounts are shown in thousands of dollars.

Other Resources								

Comments:

FY00

Project Number: 00CT/DV 00392
Project Title: Growth Rates of CT/DV in PWS
Agency: U. S. Forest Service (PNW)

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:4/9/99, KEH

2000 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
Vacant	Research Assistant		6.0	4.2		25.2
Vacant	Technicians		12.0	3.0		36.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		18.0	7.2	0.0	
					Personnel Total	$61.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
RT Corvalis to Cordova	1.3	6	42	0.12	12.8
RT Corvalis to Anchorage	1.0	2	6	0.2	3.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$16.0

FY00

Prepared:

Project Number: 00CT/DV
Project Title: Growth Rates of CT/DV in PWS
Agency: U. S. Forest Service (PNW)

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
Charter Boat 14 days @ $1.2/day	16.8
Otolith analysis - OSU	50.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$66.8

Commodities Costs:	Proposed
Description	FY 2000
collecting supplies	1.5
Commodities Total	$1.5

FY00

Prepared:

Project Number: 00CT/DV
Project Title: Growth Rates of CT/DV in PWS
Agency: U. S. Forest Service (PNW)

FORM 3B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2000
			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

FY00

Project Number: 00CT/DV
Project Title: Growth Rates of CT/DV in PWS
Agency: U. S. Forest Service (PNW)

FORM 3B
Equipment
DETAIL

Prepared:

Prince William Sound Food Webs: Structure and Change, Submitted Under the BAA

Project Number:	00393
Restoration Category:	Research
Proposer:	Prince William Sound Science Center Cordova, Alaska
Lead Trustee Agency:	NOAA
Cooperating Agencies:	
Alaska SeaLife Center:	
Duration:	Year 2, 3-year project
Contract FFY 00:	$ 143.6064K (exclusive of agency overhead),
Contract FFY 01:	$ 144.6K (exclusive of agency overhead),
Geographic Area:	Prince William Sound
Injured Resource/Service:	Fishes and their Injured Consumers, Fisheries: Commercial, Recreational, and Subsistence

ABSTRACT

Recent research has shown that the advective regime connecting the northern Gulf of Alaska (GOA) with Prince William Sound (PWS) may affect recruitment and nutritional processes in Fishes (Kline 1998b). Accordingly, food webs are subject to changes in carbon flow occurring between GOA and PWS. This project seeks to: (1) conduct retrospective analysis of GOA production shifts since EVOS, and (2) address Ecopath model validation data gaps. These analyses will enable us to gain a better understanding of the ecological role of 'regime shift" processes conjectured to be impeding the natural restoration of populations in PWS affected by the EVOS.

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?

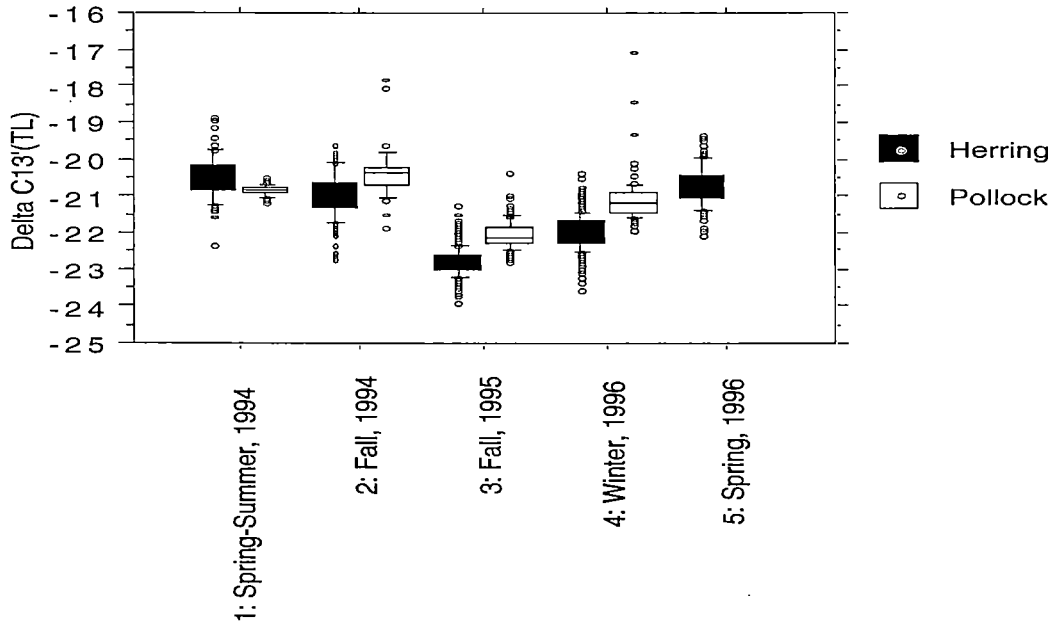


Figure 1. Shift in $^{13}C/^{12}C$ and inferred change in Gulf of Alaska (GOA) vs. Prince William Sound (PWS) carbon dependency (see Kline 1998b, for explanation of delta notation and method of data interpretation) of juvenile herring and pollock in 1994 - 6 (from Kline 1998a). The distribution of values 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.

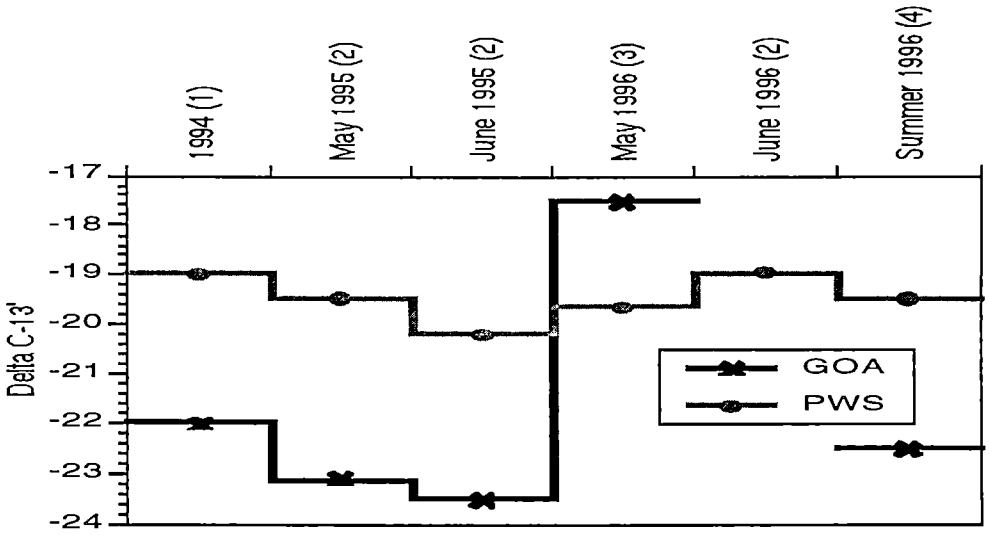


Figure 2. Time series of $^{13}C/^{12}C$ measured in feeding *Neocalanus cristatus* from Prince William Sound (PWS) and the Gulf of Alaska (GOA). Points reflect mean values, standard deviations were 0.5 to 1 delta units. PWS and GOA values were consistently statistically different (Kline 1998a, 1998b).

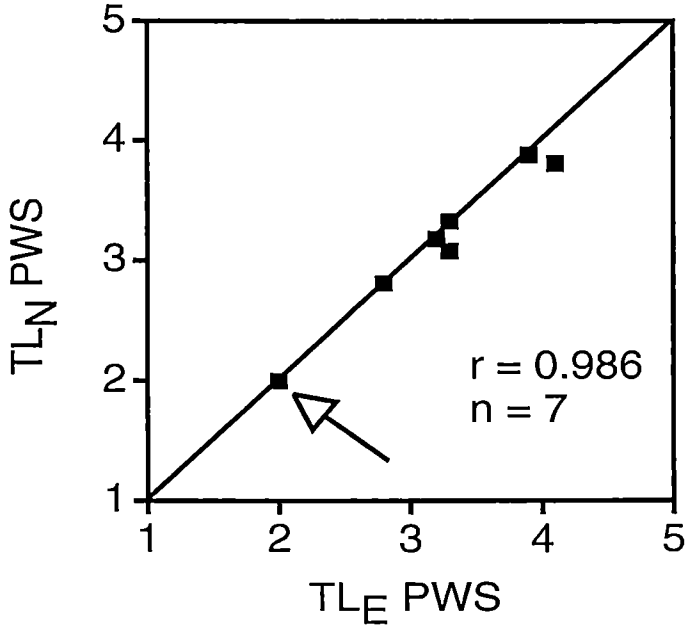


Figure 3. An example of using trophic level determined by $^{15}N/^{14}N$ content (TL_NPWS) to validate trophic level predicted by Ecopath modeling (TL_EPWS). The Arrow indicates the calibration point, remaining points are the estimated trophic level values for six Ecopath functional groups. From Kline 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 NearshorePelagics	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. Those functional groups with yes underlined in Table 1 under the column "sample accessibility" will 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 (duplicated in Kline 1998b). The data generated will used in a similar way.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

N/A

SCHEDULE

This schedule has been updated over the 1998 DPD to reflect the actual project 393 commencement day of 1 Aprill 1999. See also attached timeline.

A. MEASURABLE PROJECT TASKS for FY00 (October 1, 1999 - September 30, 2000)

Oct. 99 - Jun. 00:	Preparation of archived samples (for Objectives 1 & 2) for mass spectrometry
Oct. 99 - Sep. 00:	Mass spectrometry at UAF (~ 6-9 month processing time)
Dec. 99 - Sep. 00:	Process new isotope data

B. Project Milestones and Endpoints

Apr. 1999 - Jun. 2000:	Preparation of archived samples for mass spectrometry
Jul. 2000 - Jan. 2001:	Acquisition and preparation of new samples for mass spectrometry
Jan. 2000, 2001, 2002:	Attend Annual Restoration Workshop
Dec. 1999 - Dec. 2001:	Process new isotope data
Apr. 2000 - Dec. 2002;	Data, receipt (from mass spect lab), integration and synthesis
Oct. 1999 - Dec. 2002:	Preparation for and dissemination of results at EVOS and other Symposia
Jan. - Apr. 2000, 2001:	Preparation of Annual Reports
Jan. - Apr. 2002:	Draft final report preparation
Sept. 30 2002:	Final Report revisions

C. Completion Date

September 2002 (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 FY01-02.

Kline - A paper based on the retrospective analysis is planned for FY01.

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.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

Since approval of funding was delayed until until December 1998 and the contract was not completed until 1 April 199, the project schedule has been reset in time accordingly. It is still planned as a three-year project. See attached Timeline for details.

PROPOSED PRINCIPAL INVESTIGATOR

Thomas C. Kline Jr., Ph.D.
Prince William Sound Science Center
P. O. Box 705
Cordova, AK 99574
907-424-5800 (t)
907-424-5820 (f)
tkline@grizzly.pwssc.gen.ak.us

PRINCIPALINVESTIGATOR

T. Kline has been actively involved in stable isotope research since 1985. His has innovated applications of stable isotope analysis in fish ecology with emphasis on salmonid fishes in northern, western, south central and southeast Alaska. His techniques has enabled the quantification of the effect of salmon carcass nutrient input to juvenile sockeye salmon production. This research has been the first to provide direct evidence for the importance of salmon carcasses for juvenile salmon production (Kline et al. 1990) . His stable isotope models also enable the quantification of different sources of production important in salmon ecosystems (Kline et al. 1993). Dr. Kline also led an investigation relating feeding strategies to growth forms in North Slope salmonids (Kline et al. 1998). His on-going efforts include collaborations with ADF&G, the North Slope Borough, and BPX. The results of these projects have been presented in numerous scientific papers as well as in public forums (speaking to local groups and classes). T. Kline initiated project 320I which has been the first comprehensive project using natural stable isotopes in Prince William Sound. Through this project he has developed new models and application of natural stable isotope abundance methods (Kline 1997, Kline and Pauly 1998). He was the first to provide direct evidence of the importance of carbon from the Gulf of Alaska in Prince William Sound (Kline 1997, 1998). Kline also has previous experience in aging bivalve mollusks using their annual growth checks (Kline 1983); this of particular relevance for Objective 1.

OTHER KEY PERSONNEL

Fish Biologist: J. Williams. PWSSC. J. Williams received his Masters degree in Fisheries from Texas A&M University in 1995. While earning his degree, he spent one year conducting field research in a remote are of Venezuela, successfully incorporating native fishermen in his survey of reservoir fish populations. His research has been presented in a variety of forums and is currently under review for journal publication. J. Williams is a certified Rescue Diver, Divemaster and has eleven years of diving experience. He has recently become certified as a Scientific Diver, fulfilling American Academy of Underwater Science standards, in the PWSSC Scientific Diving Program. J. Williams is tasked with sample and data processing and data management for this project and will actively contribute to data synthesis.

LITERATURE CITED

Anderson, P.J., J.E. Blackburn, and W.R. Bechtol. 1996. APEX Project Component L - Synthesis and analysis of Gulf of Alaska small-mesh trawl data 1953 to 1995. Abstracts of 1996 Restoration Projects. *Exxon Valdez* Oil Spill Trustee Council. Anchorage, Alaska.

Bridigare, R.R. and 15 other authors. 1997 Consistent fractionation of ^{13}C in nature and in the laboratory: Growth-rate effects in some haptophyte algae. Global Biogeochemical Cycles. In press.

Brodeur, R.D. and D.M. Ware. 1992. Long-term variability in zooplankton biomass in the subarctic Pacific Ocean. Fish. Oceanogr. 1:32-38.

Cooney, R.T. 1988. Distribution and ecology of zooplankton in the Gulf of Alaska: a synopsis. *In:* (Nemoto, T. and W.G. Pearcy (eds.) The biology of the subarctic Pacific, proceedings of the Japan-United States of America seminar on the biology of micronekoton of the subarctic Pacific, Part I. Bull. Ocean Res. Inst., University of Tokyo. p. 27-41.

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

Francis, R.C. and S.R. Hare. 1994. Decadal-scale regime shifts in the large marine ecosystems of the northeast Pacific: a case for historical science. Fish. Oceanogr. 3:279-291.

Fry, B. 1988. Food web structure on Georges Bank from stable C, N, and S isotopic compositions. Limnol. Oceanogr. 33:1182-1190.

Laws, E. A., B. N. Popp, R. R. Bridigare, M. C. Kennicut, and S. A. Macko. 1995. Dependence of phytoplankton carbon isotopic composition on growth rate and $[CO_2]aq$: Theoretical considerations and experimental results. Geochem. Cosmochim. Acta. 59:1131-1138.

Kline, Thomas Clayton, Jr. 1983. The effect of population density on the growth rate of the butter clam, *Saxidomus giganteus*. M. S. Thesis, University of Washington, Seattle, 104pp.

Kline, T. 1997a. Sound Ecosystem Assessment: Confirming food web dependencies in the Prince William Sound Ecosystem using stable isotope tracers, *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 96320I), Prince William Sound Science Center, Cordova, Alaska.

Kline, T.C. 1997b. Confirming forage fish food web dependencies in Prince William Sound using natural stable isotope tracers. *In:* Forage Fishes in marine Ecosystems, Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems. Alaska Sea Grant College Program report No. 97-01. University of Alaska Fairbanks. Pp. 257-269.

Kline, T.C. 1998a. Carbon and Nitrogen Isotopic Composition of Prince William Sound Pelagic Biota Shift on Annual Time Scales: A Tool for Monitoring Changes in Oceanographic Forcing. EOS Trans. AGU, 79(1), Ocean Sciences Meet. Suppl., OS53.

Kline, T.C. 1998b. Scales and Patterns of Temporal and Spatial Variability of $^{13}C/^{12}C$ and $^{15}N/^{14}N$ in Pelagic Biota. *In:* Sound Ecosystem Assessment: Confirming fish food web dependencies in the Prince William Sound Ecosystem using stable isotope tracers, *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 97320I), Prince William Sound Science Center, Cordova, Alaska. Can. J. Fish. Aquat. Sci. In Press.

Kline, T.C. and D. Pauly. 1998. Cross-validation of trophic level estimates from a mass-balance model of, and $^{15}N/^{14}N$ data from, Prince William Sound. Proceedings of the International Symposium on Fishery Stock Assessment Models for the 21st Century -- Combining Multiple Data Sources. Alaska Sea Grant College Program Report. University of Alaska Fairbanks. In Press.

Kline , T. C. Jr., J. J. Goering, O. A. Mathisen, P. H. Poe and P. L. Parker. 1990. Recycling of elements transported upstream by runs of Pacific salmon: I. $\delta^{15}N$ and $\delta^{13}C$ evidence in Sashin Creek, southeastern Alaska. Can. J. Fish. Aquat. Sci. 47:136-144.

Kline, T.C. Jr., J.J. Goering, O.A. Mathisen, P.H. Poe, P.L. Parker, and R.S. Scalan. 1993. Recycling of elements transported upstream by runs of Pacific salmon: II. $\delta^{15}N$ and $\delta^{13}C$ evidence in the Kvichak River watershed, southwestern Alaska. Can. J. Fish. Aquat. Sci. 50:2350-2365.

Kline, T. C. Jr., W. J. Wilson, and J.J. Goering. 1998. Natural isotope indicators of fish migration at Prudhoe Bay, Alaska. Can. J. Fish. Aquat. Sci. 55: In Press.

Minagawa, M., and E. Wada. 1984. Stepwise enrichment of ^{15}N along food chains: Further evidence and the relation between $\delta^{15}N$ and animal age. Geochim. Cosmochim. Acta 48:1135-1140.

U.S. GLOBEC 1996. Northeast Pacific Implementation Plan. U.S. GLOBEC Report No. 17. University of California, Berkeley, CA 60pp.

Project 393 Schedule

	Old (rev. DPD)		**Actual**		Ecopath workshop	Prepare archived samples (obj 1 & 2) for mass spect	Acquisition and Preparation of new samples for mass spect	Mass spectrometry at UAF (6-9 month process. time)	Process new isotope data	Data Synthesis	EVOS-TC Workshop	Prep Annual Report	Final Report
FY	C-year	month	**C-year**	**month**									
1999	1998	Oct	**1999**	**Apr**	Oct 98	Start							
1999	1998	Nov	**1999**	**May**		*							
1999	1998	Dec	**1999**	**Jun**		*							
1999	1999	Jan	**1999**	**Jul**		*		Start					
1999	1999	Feb	**1999**	**Aug**		*		*					
1999	1999	Mar	**1999**	**Sep**		*		*					
1999	1999	Apr	**1999**	**Oct**		*		*					
1999	1999	May	**1999**	**Nov**		*		*					
1999	1999	Jun	**1999**	**Dec**		*		*	Start				
1999	1999	Jul	**1999**	**Jan**		*		*	*		*		
1999	1999	Aug	**2000**	**Feb**		*		*	*			Start	
1999	1999	Sep	**2000**	**Mar**		*		*	*			*	
2000	1999	Oct	**2000**	**Apr**		*		*	*	Start		*	
2000	1999	Nov	**2000**	**May**		*		*	*	*		Complete	
2000	1999	Dec	**2000**	**Jun**		Complete		*	*	*			
2000	2000	Jan	**2000**	**Jul**			Start	*	*	*			
2000	2000	Feb	**2000**	**Aug**			*	*	*	*			
2000	2000	Mar	**2000**	**Sep**			*	*	*	*			
2000	2000	Apr	**2000**	**Oct**			*	*	*	*			
2000	2000	May	**2000**	**Nov**			*	*	*	*			
2000	2000	Jun	**2000**	**Dec**			*	*	*	*			
2000	2000	Jul	**2000**	**Jan**			Complete	*	*	*	*		
2000	2000	Aug	**2001**	**Feb**				*	*	*		Start	
2000	2000	Sep	**2001**	**Mar**				*	*	*		*	
2001	2000	Oct	**2001**	**Apr**				*	*	*		*	
2001	2000	Nov	**2001**	**May**				*	*	*		Complete	
2001	2000	Dec	**2001**	**Jun**				*	*	*			
2001	2001	Jan	**2001**	**Jul**				*	*	*			
2001	2001	Feb	**2001**	**Aug**				*	*	*			
2001	2001	Mar	**2001**	**Sep**				*	*	*			
2001	2001	Apr	**2001**	**Oct**				Complete	*	*			
2001	2001	May	**2001**	**Nov**					*	*			
2001	2001	Jun	**2001**	**Dec**					Complete	*			
2001	2001	Jul	**2001**	**Jan**						Complete	*		Start
2001	2001	Aug	**2002**	**Feb**									*
2001	2001	Sep	**2002**	**Mar**									*
2001	2001	Oct	**2002**	**Sept**									Draft
2001	2001	Dec	**2002**	**Dec**									Final

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized *'FY 1999	Proposed FY 2000						
Personnel		$0.0						
Travel		$0.0						
Contractual		$143,606.4						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$116.8K	$143,606.4			Estimated *'FY 2001	Estimated FY 2002		
General Administration	$8.2K	$2,884.6						
Project Total	$125K	$146,491.0			$122.6			
Full-time Equivalents (FTE)		1.2						
	*'Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: long range estimates are based on 7% G.A.

FY00

Prepared:

Project Number: 00393
Project Title:Prince William Sound Food Webs: Structure and Change, Submiited Under the BAA
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000						
Personnel		$86,442.0						
Travel		$3,830.0						
Contractual		$23,400.0						
Commodities		$2,500.0						
Equipment		$3,500.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$116.8K	$119,672.0			Estimated FY 2001	Estimated FY 2002		
Indirect	$8.2K	$23,934.4						
Project Total	$125K	$143,606.4			$114.6			
Full-time Equivalents (FTE)		1.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: Long range estimates do not include agency G.A.

FY00

Prepared:

Project Number: 00393
Project Title: Prince William Sound Food Webs: Structure and Change, Submiited Under the BAA
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2000
	T. Kline	Principal Investigator	6.0	8561.0		51,366.0
	J. Williams	Technician	4.0	5311.0		21,244.0
	TBN	Technician	4.0	3458.0		13,832.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	14.0	17330.0	0.0	
					Personnel Total	$86,442.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2000
	National meeting	800.0	1	7	132.0	1,724.0
	registration and car rental	250.0	1	5	50.0	500.0
	EVOS and collaborative workshops	200.0	2	6	151.0	1,306.0
	registration and car rental	100.0	1	4	50.0	300.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$3,830.0

FY00

Prepared:

Project Number: 00393
Project Title:Prince William Sound Food Webs: Structure and Change, Submiited Under the BAA
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

Contractual Costs:				Proposed
Description				FY 2000
PWSSC network charge by computer-months	computer months: 11		cost per: $100	1,000.0
Stable Isotope Analysis	number:	700	cost per: $27	18,900.0
Freeze drier charge	number:	700	cost per: $3	2,100.0
photocopying				200.0
shipping				300.0
communications (fax and phone)				400.0
page charges				500.0
			Contractual Total	$23,400.0

Commodities Costs:	Proposed
Description	FY 2000
Lab supplies miscl	750.0
Lab supplies: chemicals, vials, knives	750.0
Office supplies miscl	400.0
Computer supplies and upgrades	400.0
Dyesub, photog. (presentation materials)	200.0
Commodities Total	$2,500.0

FY00

Prepared:

Project Number: 00393
Project Title: Prince William Sound Food Webs: Structure and Change, Submiited Under the BAA
Name: Prince William Sound Science Center

FORM 4B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2000
Computer	1	3500.0	3,500.0
			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**		$3,500.0

Existing Equipment Usage:	Number	
Description	of Units	

FY00

Prepared:

Project Number: 00393
Project Title: Prince William Sound Food Webs: Structure and Change, Submiited Under the BAA
Name: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

Diet, Trophic Interactions, and Historical Trends in Occurrence of Salmon Sharks (*Lamna ditropis*), Sleeper Sharks (*Somniosus pacificus*), and Spiny Dogfish (*Squalus acanthias*) in Prince William Sound and the Eastern Gulf of Alaska

Project Number:	00396
Restoration Category:	Research
Proposer:	Leland B. Hulbert NMFS, Auke Bay Laboratory ABL Program Manager, Dr. Stan Rice NOAA Program Manager, Bruce Wright
Lead Trustee Agency:	NOAA
Cooperating Agencies:	none
Alaska Sea Life Center:	no
Duration:	Year 1 of 2 year project
Cost FY 00:	42.1K
Cost FY 01:	42.1K
Geographic Area:	Prince William Sound, eastern Gulf of Alaska
Injured Resource/Service:	Pink salmon, Sockeye salmon, Pacific herring, Rockfish

ABSTRACT

Reports of an increasing trend in the abundance of sharks in Prince William Sound and the eastern Gulf of Alaska have come to the attention of biologists, and commercial and sport fishermen, in recent years. In regions of high abundance, sharks have the potential to significantly impact a number of commercially and ecologically important species. This project encompasses a unique approach to understanding trends in abundance, and trophic dynamics, of these apex predators. A number of short and long term time-series of shark by-catch data are available for a retrospective analysis of spatial and temporal patterns of distribution and abundance. Refining the shark diet parameters in the PWS Ecopath model, through analysis of shark stomach samples, will elucidate important ecosystem linkages representing species interactions. This project will provide a valuable contribution to the understanding of shark ecology, and document predator-prey interactions in the PWS and GOA ecosystems.

INTRODUCTION

In recent years, we have become increasingly aware of the dynamic nature of the Gulf of Alaska (GOA) ecosystem. Ecosystems are complex, response times are often long, and biological effects can cause unexpected outcomes. A case in point is the evidence indicating an increasing trend in abundance of the predominant shark species in the region throughout the 1990's. Unpublished survey data (Bill Bechtol and Dan Randolf pers. comm.) and an abundance of anecdotal accounts indicate that salmon sharks (*Lamna ditropis*), sleeper sharks (*Somniosus pacificus*), and spiny dogfish (*Squalus acanthias*) are all dramatically more abundant in the eastern GOA and Prince William Sound (PWS) in recent years.

Increased shark abundance could be a natural consequence that follows an ecological succession in response to the documented changes in marine community structure in the region during the past two decades (Bechtol 1997, Anderson et al. 1997, Piatt et al. 1996). Many shark species, including salmon, sleeper, and spiny dogfish sharks have low fecundity, long gestation periods, long life, and slow maturation. Because of the long generation time of these species, it may be that shark succession in the community structure is only recently being realized. Once sharks reach a dominance level in the community, however, they are likely to continue that dominance for a long time.

A dramatic increase in shark biomass in the region has potential implications within system structures in PWS and the GOA. Historical catch records and the PWS Ecopath model are valuable sources of information with which to address these issues. This project will report on trends in the spatial and temporal distribution in shark species in the region from a retrospective analysis of commercial fisheries and survey catch data, and will refine the PWS Ecopath model parameters of consumption and diet composition for sharks through stomach analyses. Demographics of the shark species, and documented temporal changes in the physical environment and trophic structures in the region, will be also be analyzed within this context. This work will shed light on the effects of shark populations on commercially and ecologically important prey species and will contribute to our understanding of their role as predators in the eastern north Pacific.

Currently, the PWS Ecopath model indicates sharks may already have a significant impact on the PWS ecosystem. The attached PWS Ecopath simulation shows what may happen if shark numbers are altered (See attached Figure1. in the appendix).

NEED FOR THE PROJECT

A. Statement of the Problem

There is currently a void in our understanding of the ecology and changes in relative abundance of the three predominant shark species (salmon, sleeper, spiny dogfish) in PWS and the eastern GOA. There is evidence to suggest that the occurrence and abundance of all three of these species have increased in the region in recent years. This trend has been widely recognized by commercial and sport fishermen, and biologists conducting research in the region during the 1990's. In regions of high abundance, these sharks have the potential to significantly impact a

number of commercially and ecologically important species. Diet composition from stomach contents and trends in spatial and temporal distribution from historical fishery and survey by-catch data have not been analyzed. Data from these analyses are needed to refine the PWS Ecopath model parameters and will improve the overall integrity of the model. These are cost-effective methods that are needed to clarify our understanding of the trends in abundance and trophic dynamics of sharks in the region.

Although there is anecdotal evidence that suggests an increase in abundance of sharks in PWS and the GOA, historical data documenting trends in relative distribution, abundance, and seasonal residency of sharks in the region has not been analyzed. Salmon sharks, spiny dogfish and sleeper sharks are commonly taken by survey and commercial fishing gear and are particularly well represented in Alaska's pelagic trawl pollock fishery and in the longline fisheries for sablefish, halibut, and Pacific cod. A retrospective analysis of spatial and temporal shark by-catch data trends in the region is important to qualify the role of these apex predators in a dynamic trophic community structure.

Sharks inhabiting Alaskan waters have low fecundity, long gestation periods, long life, and slow maturation. Because of the long generation time of sharks, an increase in their abundance could be the result of a delayed response to changes in community structure that are only recently being realized. Demographics of the three shark species need to be considered within the retrospective analysis of trends in abundance to determine whether the time elapsed between the documented trophic shifts and increases in shark abundance allows for the long generation times of these species. Because of the size and longevity of these apex predators, evidence of the ascension of sharks in the community structure of the region would likely indicate that their dominance would persist for a long time.

Currently there are no quantitative estimates of shark diet in PWS. The PWS Ecopath model estimates for consumption and diet composition are based on few available data. Refining the shark diet parameters in the model is needed to delineate important ecosystem linkages representing species interactions such as predator-prey relationships. One of the more cost-effective methods of assessing complex interactions of a food web is diet analysis from stomach contents. A particular challenge lies in acquiring stomach samples from shark species that represent a seasonal variation in diet. Cooperation has been established with commercial and sport fishermen and the Alaska Department of Fish and Game (ADF&G) to support sampling efforts to acquire seasonal shark stomach samples in PWS. Accumulation of diet data from stomach samples will support the PWS Ecopath model and will provide clues to the trophic relationships of these sharks.

B. Rationale

There has been much speculation about the ecological consequences and causation of an increase in shark abundance in the GOA. In regions of high abundance, these sharks have the potential to significantly impact a number of commercially and ecologically important species. This project will address these questions by targeting two primary objectives; 1. collect and analyze shark stomach samples; and 2. analyze historical trends in spatial and temporal shark distribution and

abundance in relation to shark demographics and indices of environmental and ecological change in the region.

The ecological consequences of an increasing trend in shark biomass needs to be addressed in the context of trophic dynamics by refining Ecopath model parameters for shark consumption and diet composition (See the results of a simulated removal of sharks from PWS, appendix Figure 1.). Quantitative estimates of consumption and prey composition from stomach samples, and documentation of spatial and temporal trends in shark abundance from the retrospective analysis, will help refine an important component of the Ecopath Trophic Mass Balance Model of Alaska's Prince William Sound (Oakey et al. 1998). Refining these parameters will improve the overall integrity of the Prince William Sound Ecopath model (Tom Oakey 1999 pers. comm.).

Research correlating the evidence relating to trends in abundance and trophic dynamics of the predominant shark species in the Prince William Sound region is needed to address the role of sharks in the dynamic physical and trophic structures in Alaska's marine environment. This research will provide a valuable contribution to the understanding of shark ecology and document predator/prey interactions in the PWS and GOA ecosystems.

C. Location

Prince William Sound and the eastern Gulf of Alaska

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

During the retrospective analysis of this study a traditional and local knowledge component will be incorporated. The villages of Cordova, Chenega, and Tatitlik will be asked to further our knowledge of historical shark abundance and distribution. Depending on the results of these discussions, and our voluntary sampling program, local fishermen may be hired to catch sharks for stomach samples in both the early spring and late fall when gaps in temporal comparisons of diet composition are likely to occur.

PROJECT DESIGN

A. Objectives

1. Retrospective Data Analysis: Analyze trends in the spatial and temporal distribution and abundance of shark species in the region through use of historical references, log books, survey and incidental commercial by-catch records, research and management agency publications, surveys, interviews, and in-field observations.

2. Analyze Available Shark Stomachs: Collect and analyze stomach samples from salmon sharks, spiny dogfish, and sleeper sharks during different times of the year to quantify seasonal estimates of diet composition.

3. Produce a Restoration Notebook series on sharks of PWS.

B. Methods

The seasonal shark diet analysis component of this project will obtain stomach samples from a variety of sources:

1. Voluntary and opportunistic contributions of shark by-catch from the PWS commercial fishing fleet: herring purse seiners (April, November), salmon purse seiners (July/ Aug), sablefish/ halibut longliners (Feb/March), salmon gillnetters (June/ July), walleye pollock trawlers etc..

2. Salmon shark samples from PWS sport fishing charter operators. The samples will be acquired from voluntary contributions and/or during on-board participation as an observer. Fishermen who have expressed an interest in participating are: Bob Candopoulos (Saltwater Safari Co., Seward), Bob Day (Sound Adventures, Seward), and Luke Borer (sport fishing charters, Cordova). These fishermen will collect samples in July and August, the period of highest concentration of salmon sharks in the region.

3. Participation aboard the vessel R.V. Montague during the ADF&G October PWS sablefish longline survey. (Invitation from chief scientist, Bill Bechtol)

4. Charter a local PWS commercial fisherman to catch sharks during periods when gaps in temporal comparisons of diet composition are likely to occur.

Stomach contents analysis will occur in one of two ways: 1) The contents will be identified onboard the collection vessel or, 2) The stomachs will be removed, frozen, and shipped to the National Marine Fisheries Service, Auke Bay Laboratory (ABL) for identification. Standard methods for these procedures will include weighing the full gut, identifying all contents to the highest taxonomic resolution possible, estimating the volumetric and weight component of each prey item or prey group, counting the total items, and weighing the empty gut. Seasonal species composition of diet for each of the shark species will be determined by %weight, %volume, and % frequency of occurrence.

Vertebrae samples will be frozen and sent to Ken Goldman at VIMS for age determination. He will be producing an age-growth relationship and modeling the demographics of salmon sharks in Gulf of Alaska waters. Spiny dogfish dorsal spines will be sampled and shipped to ABL for age determination analyses.

Stanford University professor Barbara Block will provide archival satellite tags to monitor short and long-term movements and behavior of salmon sharks. The PI will deploy the tags, and Professor Blocks program will perform the tracking of the sharks and share the data.

The retrospective analysis will address historical trends in shark observations and by-catch from a variety of sources; trends in the spatial and temporal distribution and abundance of shark species in the region will be determined through use of historical references, log books, survey

and incidental commercial by-catch records, research and management agency publications, surveys, interviews, and in-field observations. This analysis will document frequency of occurrence and catch per unit effort, in addition to environmental changes, as indices of trends in abundance. GIS plots will be used to indicate annual and seasonal variation in spatial distribution of sharks in the region. Shark species demographics, and documented temporal changes in the physical environment and trophic structures in the region, will be analyzed with respect to evidence of temporal changes in shark distribution and abundance.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The major activities for this project include use of NOAA/ NMFS/ ABL biological lab space for sample analysis and storage, access to agency library materials and literature, and computers for database management and statistical analysis.

The Virginia Institute of Marine Science (VIMS), via Ken Goldman, will contribute all salmon shark stomach samples collected during their sampling efforts over the course of their research.

The Alaska Department of Fish and Game, via Jim Blackburn, will provide a collaborative contribution to the retrospective analysis of historical trends in shark distribution and abundance through analysis of data collected in small mesh trawl surveys in the Kodiak region.

The Alaska Department of Fish and Game will provide platform time aboard the Research Vessel Montague for sleeper and spiny dogfish shark diet studies during the October sablefish longline surveys in PWS.

The Alaska Department of Fish and Game will contribute any shark stomach samples they collect in their field and port sampling programs.

Stanford University, via Barbara Block, will provide satellite tags and her program will perform the tracking of the sharks.

SCHEDULE

A. Measurable Project Tasks for FY 99-02 (October 1, 1999-April 15, 2002)

October 1999:	Conduct spiny dogfish and sleeper shark diet sampling and tagging aboard the ADF&G vessel R.V. Montague.
	Acquire samples collected by previous arrangement during 1999 field work conducted by Ken Goldman (VIMS), the ADF&G, and others.
October 1999-March 2000:	Analyze stomach contents of shark specimens collected during the previous year.

	Collect and begin analysis of historical fishery and survey shark by-catch data.
	Interview PWS commercial sablefish, halibut, and pollock fishermen concerning shark by-catch taken during winter months. Request samples.
	Produce and distribute a shark survey to PWS and eastern GOA fishermen. (United Salmon Association and Copper River Salmon Producers Association)
	Interview villagers and local fishermen concerning their historical observations of sharks in the region.
	Attend EVOS annual meeting and present a poster.
April 2000-October 2000:	Collect and analyze samples from directed sampling charter and contributions from ADF&G, commercial and sport fishermen, and others.
	Conduct spiny dogfish and sleeper shark diet sampling and tagging aboard the ADF&G vessel R.V. Montague.
Nov. 2000-January 2001:	Data write up, preparation for EVOS annual meeting.
January 2001:	EVOS Annual meeting, PI will present results from first year.
March 2001-Sept. 2001:	Produce an annual report on diet composition, historical trends in abundance, and Ecopath model refinements, for the three shark species.
	Collect and analyze samples from agencies and commercial and sport fishermen/charters.
October 2001-April 2002:	Collect and analyze samples as per previous sources and methods.
	Produce final report and Sharks section for submission to the Restoration Notebook series publication.

B. Project Milestones and Endpoints

FY 00:
Milestone: Collect stomach samples of the three shark species, representing seasonal variation in diet in the region, from a variety of sources.
Milestone: Collect and analyze historical fishery and survey shark by-catch data from a variety of sources.

FY 01:
Milestone: Add to seasonal diet composition database and update historical fishery and survey shark by-catch trends from data sources.
Endpoint: Produce an annual report on seasonal and inter-annual comparisons of diet composition, historical trends in abundance, and Ecopath model refinements, for the three shark species.

April 15, 2002:
Milestone: Cooperative data sharing.
Endpoint: Produce a final report with quantitative aspects.
Endpoint: Restoration Notebook series publication

C. Completion Date

April 15, 2002

PUBLICATIONS AND REPORTS

At least three written products will be produced from this study:

1. An annual report will describe the results and accomplishments of the research to date.
2. An EVOS final report and/or NOAA technical report, describing a synthesis of retrospective analysis, predator-prey interactions and trophic dynamics, and changes in the ecology of the region. The report will summarize results in terms of spatial and temporal variation in abundance and diet of the three shark species in PWS and eastern GOA, and will quantify refinements to shark parameters in the PWS Ecopath model. Ecosim simulations based on parameter refinements will provide clues to the trophic relationships of these sharks.
3. A Restoration Notebook series publication

PROFESSIONAL CONFERENCES

The PI will attend the EVOS Annual Meeting in the winter of 2000.

NORMAL AGENCY MANAGEMENT

The activities proposed in this project are beyond what NOAA and ADF&G would be expected to do or have funding for.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The information gathered in this study may be useful to understanding the lack of recovery of some non-recovering species (marine birds, harbor seals, Pacific herring).

PROPOSED PRINCIPAL INVESTIGATOR

Leland (Lee) B. Hulbert
Auke Bay Laboratory, NMFS
11305 Glacier Highway
Juneau, Alaska 99801-8626
(907)789-6056
FAX (907)789-6094
E-MAIL: Lee.Hulbert@noaa.gov

Lee has been employed as a Fisheries Research Biologist at the Auke Bay Laboratory, NMFS for two years and has three years-prior work experience in fisheries biology at ABL. He has extensive commercial fishing experience in Prince William Sound and has also fished commercially in Bristol Bay, Togiak, Cook Inlet, the Gulf of Alaska, and S.E. Alaska. He has worked on the APEX Forage Fish Component (163C) for over 2 years. He is currently a CO-PI on the EVOS Alaska Predator Ecosystem Experiment (APEX) Forage Fish Assessment Project (163A). Lee holds a B.S. degree (1992) in Fisheries Biology from Humboldt State University.

In recent months Lee has developed a web site (http://www.fakr.noaa.gov/oil/sharks.htm) describing biology, ecology, and management issues pertaining to the predominant shark species in Alaska's coastal waters. He has also contributed a shark component to the Prince William Sound Ecopath Trophic Mass-balance Model (Oakey et. al. 1998), and has provided considerable information for preparation of the North Pacific Fisheries Management Councils Federal Draft Management Plan for Sharks in the Gulf of Alaska (Jane DiCosimo 1999 pers. comm).

LITERATURE CITED, PERSONAL COMMUNICATIONS

Anderson, P.J., J.E. Blackburn, and B.A. Johnson. 1997. Declines of Forage Species in the Gulf of Alaska, 1972-1995, as an indicator of Regime Shift. In: Forage Fishes in Marine Ecosystems. Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems. Alaska Sea Grant College Program Report No. 97-01. University of Alaska Fairbanks, 1997. pp. 531-543.

Bechtol, William R. 1997. Changes in Forage Fish Populations in Kachemak Bay, Alaska, 1976-1995. In: Forage Fishes in Marine Ecosystems. Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems. Alaska Sea Grant College Program Report No. 97-01. University of Alaska Fairbanks, 1997. pp. 531-543.

Oakey, T.A., & D. Pauley, 1998. Trophic Mass-Balance Model of Alaska's Prince William Sound Ecosystem, for the Post-Spill Period 1994-1996 (DRAFT report, October 1998). Fisheries Centre Research Reports, 6(4) 128p.

Piatt, J.F., and P. Anderson. 1996. Response of Common Murres to the Exxon Valdez Oil Spill and Long Term Changes to the Gulf of Alaska Ecosystem. In: S.D. Rice, R.B. Spies, D.A. Wolfe, and B.A. Wright (eds.) Exxon Valdez Oil Spill Symposium Proceedings. American Fisheries Symposium No. 18:720-737.

Dan Randolf, Personal Communication. International Pacific Halibut Commission Biologist, Seattle, WA.

Tom Oakey Personal Communication. Fisheries Centre, University of British Columbia, Vancouver, B.C., Canada.

William (Bill) Bechtol, Personal Communication. Commercial Fisheries Division, Alaska Department of Fish and Game, Homer, AK.

APPENDIX

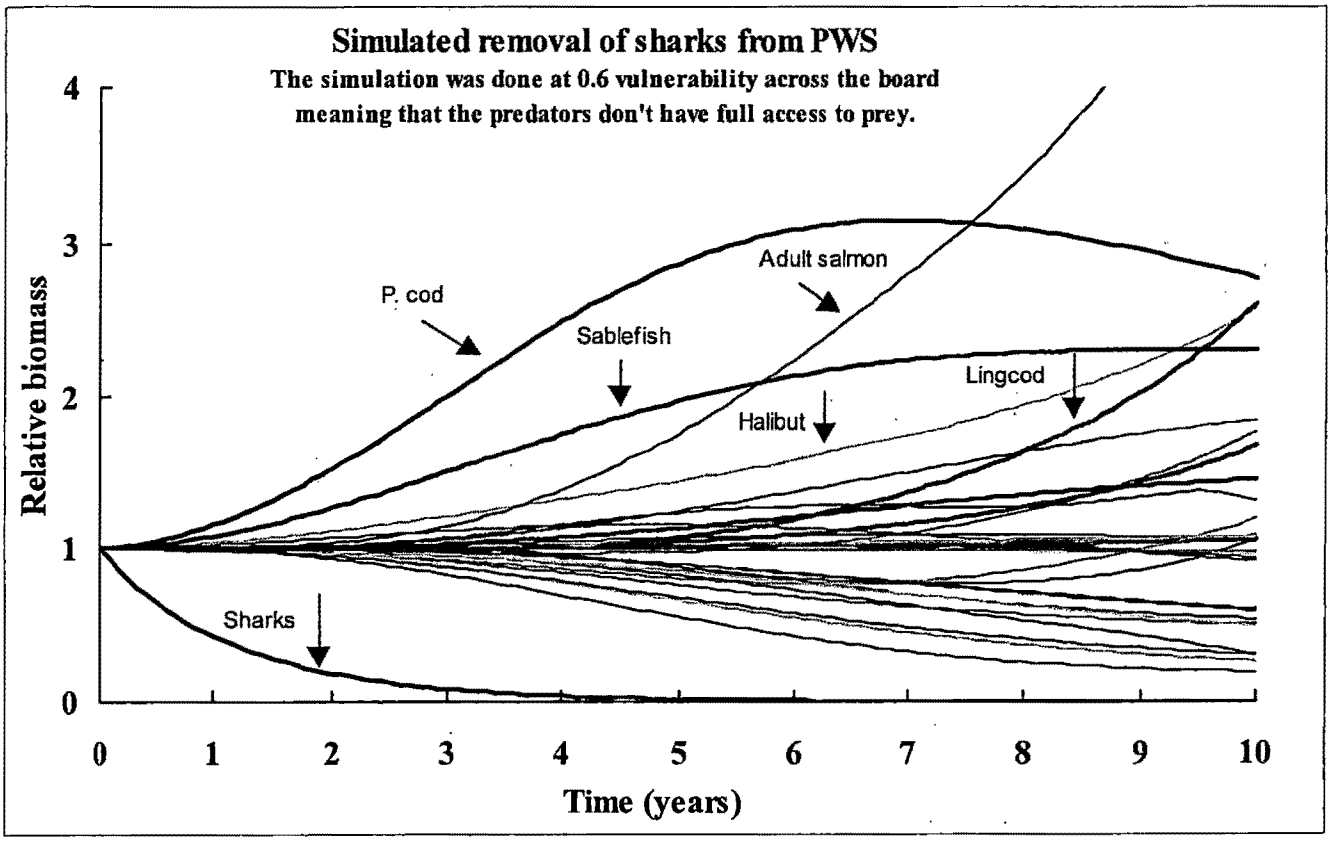


Figure 1.

Budget Category:	Authorized	Proposed FY 00						
Personnel		$26.4						
Travel		$3.5						
Contractual		$7.0						
Commodities		$0.0						
Equipment		$0.5	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$37.4		Estimated FY2001	Estimated	Estimated		
General Administration		$4.5						
Project Total	$0.0	$41.9		$42.1				
Full-time Equivalents (FTE)		0.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments

FY 00

Project Number: 00396
Project Title: Diet, Trophic Interactions, and Historical Trends in Occurrence of Salmon, Sleeper, and Spiny Dogfish Sharks in Prince William Sound and the Eastern Gulf of Alaska
Agency: NOAA/ ABL

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
Leland B. Hulbert	Fisheries Research Biologist	GS/ 9/ 1	6.0	4.4	0.0	26.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
			6.0	4.4	0.0	
	Subtotal				**Personnel Total**	$26.4

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY2000
RT Juneau to Cordova for shark study during ADF&G sablefish survey	0.4	1	8	0.2	1.6
RT Juneau to Cordova for shark fishing charter	0.4	1	5	0.2	1.1
					0.0
RT Juneau to Anchorage for EVOS Annual Meeting	0.4	1	3	0.2	0.9
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.5

FY 00

Project Number: 00___
Project Title: Diet, Trophic Interactions, and Historical Trends in Occurrence of Salmon, Sleeper, and Spiny Dogfish Sharks in Prince William Sound and the Eastern Gulf of Alaska
Agency: NOAA/ ABL

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:		Proposed FY 2000
Description		
Commercial vessel charter to catch sharks for 3 days		6.0
Shipping samples ($50/ shipment)		1.0
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$7.0

Commodities Costs:		Proposed FY 2000
Description		
none		
	Commodities Total	$0.0

FY 00

Project Number: 00___
Project Title: Diet, Trophic Interactions, and Historical Trends in Occurrence of Salmon, Sleeper, and Spiny Dogfish Sharks in Prince William Sound and the Eastern Gulf of Alaska
Agency: NOAA/ ABL

FORM 3B
Contractual & Commodities
DETAIL

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2000
Sample bottles and preservative reagents			0.5
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.5

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

FY 00

Project Number: 00___
Project Title: Diet, Trophic Interactions, and Historical Trends in Occurrence of Salmon, Sleeper, and Spiny Dogfish Sharks in Prince William Sound and the Eastern Gulf of Alaska
Agency: NOAA/ ABL

FORM 3B
Equipment
DETAIL

EVOS Data: A Proposed Archive and Enhanced World Wide Web Dissemination System

Project Number:	00398
Restoration Category:	Ecosystem Synthesis: Information Transfer to Resource Managers and Stakeholders Possible Transition to Long-Term Monitoring and Research Program
Proposer:	Environment and Natural Resources Institute University of Alaska Anchorage
Lead Trustee Agency:	Not Applicable
Cooperating Agencies:	Not Applicable
Alaska Sea Life Center:	No
Duration:	1st year, 2-year project
Cost FY00:	$158,900
Cost FY01:	$3,000
Geographic Area:	Prince William Sound
Injured Resource/Service:	All Resources

ABSTRACT

This project would develop the prototype of a comprehensive data and information management system that could archive and disseminate all past, ongoing, and future data developed through the Trustee Council's funding for Restoration Research. Through a survey of existing research projects and their associated primary deliverable products, sample data would be selected that included research final reports, GIS spatial datasets, databases, maps, and videos. These representative data types would be physically archived; integrated using ENRI's GIS, database mapping, graphic design, and library capabilities; and formated as Internet-ready products. Documentation would be written for each dataset. A graphic user interface would be designed to allow easy user access. These products would be assembled and posted on the world wide web to show an example of how EVOS restoration data could be integrated and efficiently distributed.

INTRODUCTION

The University of Alaska Anchorage's Environment and Natural Resources Institute (ENRI) proposes to develop the prototype of a comprehensive data and information management system that would archive and disseminate all past, ongoing, and future data and information developed with support from the Trustee Council. The proposed system would feature 1) online access to fully searchable files in a variety of formats and 2) a restricted access, vault-like, hard-copy repository of original data and information. The online archive would be constructed using off-the-shelf information and data management software that was custom configured and installed in a PC environment. It would support ready access to the information and data by scientists and all others who were reasonably proficient with computing technology. Those who were not proficient would continue to be served by traditional library services, such as those provided by the Alaska Resources Library and Information Services (ARLIS) and its links. The restricted access, hard-copy archive would provide secure storage for all EVOS-related data and information to guard against any deliberate or accidental corruption of the online archives over time. ENRI would review electronic media storage lifespans and selected security issues and propose the archival methods best suited for permanent storage of EVOS electronic datasets. Access to the restricted archive would be gained only with authorization from a Trustee Council gatekeeper. The proposed data and information management system would support all of the Trustee Council's restoration-related objectives by assuring that all data and information generated by Trustee Council decisions were 1) readily available to support further scientific studies and restoration-related resource management decision-making processes and 2) protected against inadvertent loss or malicious tampering.

The outstanding features of the proposed information management system are threefold: the system would allow a user the ability to survey existing data comprehensively, access what is needed, and download data in a format that could be manipulated for a wide variety of application purposes. For example, a marbled murrelet researcher could efficiently search for, access, and download the entire collection of marbled murrelet data for Prince William Sound, including all published reports, background survey data, and associated maps and graphics, as well as all spatial data layers showing bird survey locations (Geographic Information System datasets).

ENRI is admirably well suited to undertake the proposed project, as the responsibilities of data and information management, dissemination, and public service are keystone elements of its mission. ENRI's foundation program, the Arctic Environmental Information and Data Center (AEIDC), was founded 27 years ago by state legislative action specifically for these purposes, and this theme is shared in part by each of the Institute's other three programs, which include the Alaska Natural Heritage Program (AKNHP), the Alaska State Climate Center, and Resource Solutions. The proposed project would be staffed by experts in the fields of data and information management who are assigned to AEIDC and AKNHP. These individuals offer outstanding credentials in the areas of information and data archiving and delivery. The primary

responsibility for developing and managing the heart of the proposed archive's electronic infrastructure would be assigned to senior AKNHP staff, who have demonstrated expertise in the fields of electronic database design, construction, and management. AKNHP, which was established in 1989, is one of 50 such programs established across the nation by The Nature Conservancy. Its role is to catalog rare, threatened, and endangered species and their habitats, and it has developed and maintains several electronic (and other more traditional) databases for this purpose. These include the relational Biological Conservation Database, a plant community inventory and classification database, a rare species map collection, and a rare species literature collection. This database system and associated methodology was the national winner of the Smithsonian Institution's Computerworld prize for the software application with the most beneficial impact on society. In addition, AKNHP has developed a web-based distribution system for the dissemination of its biological data products. This system features GIS datasets integrated with database textual data. Final reports from AKNHP research projects are distributed through the web page, thus reaching a wider user audience and producing cost savings for reproduction costs.

Developing and managing the proposed system's restricted access, vault-like, hard-copy archive of original materials would be the responsibility of AEIDC, which was established in 1972 specifically as a focal point for decision makers needing information and data on Alaska. AEIDC has unparalleled experience in managing Alaska-related special collections, and it is a founding participant in ARLIS, to which it contributed a photograph collection and some 20,000 volumes of Alaska-related publications. It is staffed by professional librarians and charged with assembling and maintaining specialized collections of unpublished and difficult-to-find literature and data in both hard copy and microfiche. Using traditional library methods, AEIDC has organized a number of private and public sector collections, assumed management of several restricted access collections, and produced and disseminated in hard-copy and electronic formats specialized bibliographies and directories of research in its long history of public service. It is linked to the world's leading repositories of information and data through its membership in prominent library and related archive online networks.

NEED FOR THE PROJECT

A. Statement of Problem

Research conducted with support from the Trustee Council is presented and archived in a variety of different formats. To date, these include 127 annual reports, 107 final reports, electronic and paper survey data summaries, a CD-ROM, and a bibliography. These results are not easily accessible to all who might have need for them, and they cannot be searched in a coherent and efficient way. This problem is growing with the passage of time and the expansion of data and resulting knowledge; it needs to be addressed soon and with appropriate rigor. Up to the present,

the Trustee Council has properly focused its attention on funding Restoration Research projects directed toward injured resources. But now it is evident that attention needs to be placed on conserving what has been learned to support future research and decision making. Accordingly, the Trustee Council has identified as one of its next objectives the integration of these datasets and their effective dissemination to the research and decision-making communities. This will allow scientists and decision makers and stakeholders alike to better understand the effects of the spill on the affected ecosystem and the role of individual species as ecosystem components. Data integration will allow scientists to better predict long-term effects of the spill and provide greater insight into future research needs.

B. Rationale/Link to Restoration

Integration of and multi-point access to the growing and diverse data and related information sets are needed to maximize the efficiency of information and data storage, dissemination, and use. This would positively affect ongoing and future Trustee Council Restoration Research decision making by limiting the potential for funding redundant research and by easing the identification of holes in the existing information and databases. It would support researchers by providing rapid and assured access to all related data and information generated through Restoration Research activities. This would allow comparative analyses to be done and interdisciplinary exchanges to take place, as well as reduce information search costs. Initial steps to meeting these important goals have already begun. For example, the Trustee Council has funded a project to integrate a limited amount of EVOS data in CD-ROM format. Additionally, a bibliography of EVOS-related research has been prepared. Also, a home page has been established on the world wide web that provides summaries of current Restoration Research activities and updates of Trustee Council and component agency activities.

In 1999, funding was provided for preparation of multi-resource species maps and for the preliminary design of an information management system for the Cook Inlet Watershed (CIMMS). GIS data layers for the Kachemak Bay Ecological Characterization project are being produced. The APEX research group has posted summaries of their work in downloadable PDF formats on ENRI's home page. Similar independent efforts have been undertaken by participating agencies. For example, the Alaska Department of Fish and Game has posted the results of its Trustee Council-supported work on the harlequin duck on the web; and the SEA project, based in Cordova, has also posted a few datasets on a home page for general use.

Such actions are laudable but fall far short of what is needed, which is a sophisticated information and data management system that provides efficient and cost-effective access to all of the data and information accumulated through the actions of the Trustee Council. Simply stated, what is needed is a system that effectively integrates both spatial and nonspatial datasets and makes them available as a web-based product. The needed system must be flexible in design

to accommodate growth as the information and databases expand and processing technologies evolve. A physical archive is also needed to guard against data corruption and loss. Designing the needed system, which would process data from their generation through distribution, will be a complex task, but the efficiencies created as a result will be substantial. Central to the design of the needed system is a clear vision of what its construction will entail, how it will accommodate the variety of data being processed, and what the user audience needs. Data standardization and proper documentation are two critical features controlling the degree to which data can be used to accurately support other (i.e., new) research purposes. These will also be the major features of a successful data distribution system.

The benefits of implementing the comprehensive data and information management system envisioned by ENRI are substantial. They include:

1. Assured preservation of the hard-earned lessons learned from the spill event.
2. Assured project documentation and data standardization.
3. Elimination of the potential for proposing parallel or redundant research.
4. Facilitating the integrated use of existing data and providing the means to integrate new data into the information base as it is developed.
5. Providing net users with a central connecting node to other data centers distributing EVOS data.
6. Providing a web-based clearinghouse for all EVOS restoration data to facilitate its use in long-term monitoring studies and its use in managing future high-latitude spill events.
7. Reduction of information search-related costs once the EVOS data were posted to a central, searchable, and fully integrated web-based archive.
8. Application of cutting edge technology in the functional areas of database management and web-based data distribution.
9. Providing a forum for the Trustee Council, EVOS researchers, data managers, and stakeholders to discuss matters pertaining to data preservation, management, and use.
10. Providing the EVOS research community with an Alaska-based source for technological capabilities and staff expertise in the areas of GIS, data management, web product design and mapping, and data archival services.

C. Location

The proposed project would be performed in Anchorage, Alaska, in ENRI's offices. The Institute occupies about 10,000 square feet of space off campus in UAA's Downtown Center, which is located at the corner of 7th and A Street. The project will benefit any user located anywhere in the world who is able to access the Internet. ENRI maintains a modern computing infrastructure and is linked to UAA's VAX mainframe and the rest of the world via a T1 link. The Institute's inventory includes numerous Pentium-based PCs; several MacIntosh platforms; two Sun

SparcStations and one Sun Ultra workstation, supporting ARC/INFO; plotters; a high-resolution scanner; a video digitizing system; digitizers; several postscript printers; and a public access library station.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

The project would make widely available the traditional and local knowledge that is part of EVOS research by posting that research on the Internet.

In order to involve the spill-affected communities in system development, steps would be taken to gather their input for the prototype system. Soon after project award, a letter describing the archive and prototype system would be sent to the mayors or village councils to solicit feedback, especially concerns and special needs that the data distribution system should address to adequately serve the local communities as a whole. The letter would alert each community to the coming system and to the fact that they will be able to access EVOS data over their Internet connections throughout their community. The system must be designed to be made easily understandable at a local community level. The input solicited will be incorporated into the final prototype system and help guide its overall design.

PROJECT DESIGN

A. Objectives

1. Perform information inventory of primary deliverables for existing restoration projects; develop an organizational protocol for tracking and storing these materials; and select and acquire sample datasets for testing.

2. Establish a centralized archive and its corresponding searchable database for EVOS restoration data, to include annual and final reports, peer-reviewed publications, and associated datasets as represented by the broad-based sampling of data for the system prototype.

3. Develop procedures for the standardization and integration of EVOS restoration data, including comprehensive dataset documentation (metadata).

4. Format prototype datasets to assure Internet readiness.

5. Create draft graphic user interface.

6. Design, load, test, edit, and evaluate draft data dissemination system.

7. Effect any necessary or desirable modifications and retest system.

B. Methods

Existing EVOS restoration data would be inventoried, and suitable reports and associated datasets would be selected, documented, and manipulated to develop the hard-copy archive and online dissemination system. Following construction of the graphic user interface, the system would be loaded and evaluated. Modifications would be made as necessary and the prototype system implemented.

The project would begin with an inventory of existing EVOS restoration data by an AEIDC librarian. Records held by ARLIS would be cross checked with Trustee Council records as necessary to assure that all of the data were accounted for. Information from this initial activity would be used to locate original copies of the reports and associated datasets, which would then be evaluated to ascertain their completeness and condition of stability. These datasets would be further evaluated to choose examples suitable to test the functional components of the system, i.e., GIS, data mangement, mapping, and graphic design. Once selected, the data that resided in electronic media only would be replicated and stored in that format as well as downloaded and copied to archival paper for preservation.

The results of the task outlined above would be used for two purposes. The first would be in planning for the proposed restricted access, vault-like, hard-copy archive. This archive would be located at ENRI and kept under lock and key by the AEIDC Program Manager. Access would be gained only with the express authorization of a to-be-designated Trustee Council representative. The materials to be archived there would be gathered systematically as required by the AKNHP team developing the online data dissemination system. On arrival at ENRI, data would be routed to the AEIDC Program Manager for logging in, entry into the archive database (which would be built using ProCite software and searchable by author, title, and keyword), and duplicated. An electronic copy would be sent to the AKNHP team for their use. The original materials and archival copies would be placed in the restricted access archive.

There are two important preliminary steps to be taken with regard to development of the online data dissemination system. The first is a data processing task to assure that the data are ready for distribution, and the second is the design and organization of the distribution system and its associated graphic user interface. The EVOS data and associated reports reside in a multitude of formats, some of which are Internet ready and many of which are not. Datasets will need to be documented so that pertinent information on such variables as formats and sources can be delivered when they are disseminated and to develop guidelines for users. Careful attention to

this task will encourage researchers to add information to the system. The graphic user interface is a critical component of the proposed system; it must be creatively designed to guide the user efficiently (i.e., directly) to the data needed and to provide such access from one (i.e., central) location on the world wide web. Note that the datasets need not all reside in the same location electronically, but they must be accessible through one point.

There are a range of alternatives that could be followed in designing the proposed system, and ENRI would work closely with the Trustee Council to custom design the best option for the user audience. The prototype would feature all of the critical hardware and software components envisioned for the final system, and it would demonstrate its ability to deliver examples of all of the various types of data generated, or likely to be generated, by EVOS researchers. The testing criterion would be established jointly by the Trustee Council and ENRI. These criterion would be used to gauge how well the prototype system addresses data processing relative to the distribution goal, data documentation, and data distribution. The test phase would demonstrate how well the prototype meets the overarching objectives of facilitating data integration and information distribution in a reliably accurate, efficient, and cost-effective manner. ENRI anticipates the testing phase to identify a range of needed modifications to the prototype before it could be formally adopted, but these are not expected to be overly troublesome or complicated.

The proposed online data dissemination system would have four functional capabilities to support the integration of sample datasets and their subsequent posting to the EVOS home page. These include GIS data processing, database management, web-based cartographics/mapping, and web-based graphics. Figure 1 shows the organizational relationship of these four components and to the hard-copy, vault-like archive that will be created to preserve the data. To maximize ease of testing, the sample datasets used in developing the prototype will be drawn from a discrete geographic area, such as Prince William Sound. ENRI will use National Standards for Metadata in documenting datasets prior to their distribution.

The GIS data processing component of the proposed system is desirable because many datasets generated by injured species research have spatial aspects to them. Said another way, many datasets have a geographic location associated with an array of descriptive data. Much of these data reside in raw or semi-processed forms (e.g., written text, electronic spreadsheet, and textual database format). Processing these data within a GIS as spatial data layers would allow their use in broader contexts with other data layers than is now possible. This would maximize the utility of the data and leverage its worth in new and previously unavailable ways. GIS-processed spatial datasets can be used to produce maps for posting on the web, and spatial data can also be posted for direct download for use in another GIS. See Figure 2 for an example of ARCVIEW data layer containing herring spawning over three years in GIS format. This is the

type of data anticipated for dissemination over the world wide web. The major functions of the proposed GIS unit include:

1. Generating automated metadata to National Metadata Standards for all GIS layers and spatial datasets, thereby providing needed documentation for their future application.
2. Coordinating distribution of existing GIS datasets.
3. Archiving existing EVOS GIS layers.
4. Providing quality control for spatial data layers.
5. Constructing GIS layers for survey data collected by researchers without GIS capabilities.
6. Preparing Internet-ready products derived from spatial data.

The database management component of the proposed system would work with researchers to define appropriate catalog methods for processing EVOS data. Envisioned is a multifaceted subsystem driven with off-the-shelf spreadsheet, statistical, and database software. This component of the proposed system would be responsible for moving data between software systems and developing effective manipulation protocols. See Table 1 for an example of fisheries data collected from aerial surveys as part of the APEX studies that shows survey data in a raw format. It is at this level that data may be most useful for application in other research projects. This data was generated in a spreadsheet and contains a geographic coordinate. This data type would be suiable to be reformatted into a GIS layer for comparison to other resource layers. Major functions of the proposed database management component include providing:

1. A place for orphan research datasets and reformatting textual datasets into spatial data layers as appropriate for integration with other spatial datasets.
2. EVOS researchers with on-call database management expert consultation services on database design, software system evaluation, data organization, report generation, and data export.
3. Database expertise and services to the Trustee Council and to EVOS researchers in the areas of quality control and metadata documentation, thereby assuring standardization of new data sets.
4. Web output from electronic datasets.
5. Data assemblage services for primary data.
6. A data transfer capacity to assure that the data distribution format is appropriate for particular users.

The cartographics/mapping component would support the system's role as a clearinghouse by generating maps for the user interface. Maps would assist users in geographically locating areas of particular interest on the clearinghouse web page and lead directly to the data required. See Figure 3 for an example of a clickable map on the AKNHP home page that interfaces to GIS databases residing beneath it. This interface helps the user locate the data geographically. Major functions of the proposed cartographics/mapping component include:

1. Providing web-based products to present spatial data.
2. Providing user interface products as needed.
3. Providing mapping capability to meet research publication needs.
4. Generating presentation materials.

The graphic design component would support the system's information dissemination function. Automated graphics have emerged as a critical component of Internet distribution methods. It is desirable to incorporate them into the proposed system's design to capitalize on their effectiveness in transferring information to diverse user groups. See Figure 4 for an example of a document in PDF format available for download as a whole over the AKNHP web page. It is in this fashion that EVOS research reports could be made available to the widest user audience. Major functions of the proposed graphic design component include:

1. Prepare PDF-formatted research reports for direct distribution over the web of all research reports.
2. Make Internet ready and load EVOS-related photos, audio records, and video.

The proposed system's management structure is outlined in Figure 1. An Information Coordinator would be the point of contact with the Trustee Council and would function as the ENRI project manager. The Information Coordinator would provide guidance to the Trustee Council and to EVOS researchers, and stakeholders in all matters pertaining to data integration and distribution. The Information Coordinator would direct questions from the Trustee Council, EVOS researchers, and stakeholders to appropriate project staff for resolution. The Information Coordinator would also oversee the flow of work in the project and take all steps necessary to see that the project stayed on time and in budget. Project management meetings would be convened as necessary to track project progress, discuss problems encountered and steps to be taken in response, and discuss evolving technologies that might have application to the task at hand or which need to be considered in the design and management of the system.

The Webmaster and the Library Scientist would reside organizationally under the Information Coordinator and have specific, supporting responsibilities (Figure 1). The Webmaster would provide the leadership and overall expertise needed to develop and manage the proposed online data dissemination task. Responsibility for constructing the proposed online data clearinghouse and its graphic user interface would be assigned to the Webmaster, who would be assisted by experienced staff competent in appropriate disciplines. The Library Scientist would oversee all aspects of management of the hard-copy, restricted access archive that would be established to preserve original data over time. The Library Scientist would be responsible for assuring that all materials transferred under the authority of the Trustee Council were accurately logged in, labeled to appropriate Library of Congress standards, entered into the archive database, and secured until authorization was received from a cognizant representative of the Trustee Council to release specific documents for specified periods of time to specific users.

Individual researchers could interact directly with all five of the proposed system's components to accomplish various ends within the context of their research. Figure 1 shows that each of the constituent components under the Webmaster's umbrella of authority would produce products for posting to the web. The proposed web-based graphic user interface and distribution system outlined in Figure 1 would provide the mechanism by which datasets would be distributed and subsequently integrated into other research and research results.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

All trustee agencies and associated researchers would be involved with the process of data dissemination. Those sample datasets used for the construction of the system prototype would require that the source agency and researcher assist in the documentation of their datasets and in the selection of an appropriate distribution format for their research data.

SCHEDULE

A. Measurable Project Tasks for FY00 (October 1, 1999 - September 30, 2000)

October 1:	Project award
October 15:	Initiate first phases of project: information inventory and survey for representative sample datasets
December 1:	Completion of information inventory and establishment of data tracking protocols (including database design using ProCite software) for the archive
December 15:	Final selection and acquisition of region-specific datasets
March 1:	Prototype datasets made Internet ready
May 15:	Completion of draft graphic user interface design
July 31:	Coordination and prototype system plan review meeting with the Trustee Council
August 15:	Revisions to prototype complete and second review by Trustee Council
September 15:	Retest and implement prototype system
September 30:	Review test results with Trustee Council; decision point for full system adoption

B. Project Milestones and Endpoints

1. Perform information inventory of primary deliverables for existing restoration projects; develop an organizational protocol for tracking and storing these materials; and select and acquire sample datasets for testing. Begin 10/15/99 and end 12/15/99.

2. Establish a centralized archive and its corresponding searchable database for EVOS restoration data, to include annual and final reports, peer-reviewed publications, and associated datasets as represented by the broad-based sampling of data for the system prototype. Begin 11/07/99 and end 12/07/99.

3. Develop procedures for the standardization and integration of EVOS restoration data, including comprehensive dataset documentation (metadata). Begin 12/15/99 and end 01/30/00.

4. Format prototype datasets to assure Internet readiness. Begin 12/15/99 and end 03/01/00.

5. Create draft graphic user interface. Begin 02/01/00 and end 05/15/00.

6. Design, load, test, edit, and evaluate draft data dissemination system. Begin 05/16/00 and end 07/31/00.

7. Effect any necessary or desirable modifications and retest system. Begin 08/01/00 and end 09/30/00.

8. Final report completion. Begin 04/01/01 end 04/15/01.

C. Completion Date

All of the project's objectives will be met in FY00 funding year. The final report will be completed April 15, 2001.

PUBLICATIONS AND REPORTS

A report will be submitted to the Trustee Council April 15, 2001, as required to summarize the research project.

PROFESSIONAL CONFERENCES

Exxon Valdez Oil Spill Symposium, March 2000, Anchorage, Alaska. A paper would be presented summarizing the project's techniques and the data system prototype. Examples of data being distributed through the system would also be presented.

NORMAL AGENCY MANAGEMENT

Not applicable.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The proposed project would have a high level of integration with restoration efforts. The data system would offer integration of a wide variety of Restoration Research. It would also foster close working relationships with researchers in processing their data, as well with the Trustee Council. We anticipate working closely with the Trustee Council to assure that the system adequately fits the need of this working body and that it will provide the overall function needed from a data distribution system.

PROPOSED PRINCIPAL INVESTIGATOR

Juli Braund-Allen
AEIDC Program Manager, Environment and Natural Resources Institute
University of Alaska Anchorage
707 A Street
Anchorage, Alaska 99501
Work (907) 257- 2733
Fax (907) 257-2707
anjb1@uaa.alaska.edu

Julie A. Michaelson
Data Manager, Alaska Natural Heritage Program
University of Alaska Anchorage
707 A Street
Anchorage, Alaska 99501
Work (907) 257- 2788
Fax (907) 257-2707
anjam1@uaa.alaska.edu

PRINCIPAL INVESTIGATOR

Juli Braund-Allen manages ENRI's Arctic Environmental Information and Data Center and is an Assistant Professor of Library Science with UAA. She has expertise in circumpolar information networks and management systems, particularly as they relate to the environmental sciences. She specializes in information gathering and synthesis utilizing a broad array of computer technologies, people networks, and traditional research methods. Ms. Braund-Allen has strong ties to arctic-related libraries, research centers, and investigators through her participation in the Polar Libraries Colloquy and as a member of the U.S. Polar Information Working Group. In 1997 she received Vice President Al Gore's Hammer Award, as well as a Certificate of Appreciation from the U.S. Department of the Interior, for her work in establishing ARLIS. In 1998 she was appointed the Special Libraries Representative to the Govenor's Library Advisory Council.

Ms. Braund-Allen would act as co-principal investigator for the project and be responsible for inventorying primary deliverables for existing restoration projects. She would develop an organizational protocol for tracking and storing the archival materials. She would also establish and secure the archive and develop its database. Ms Braund-Allen would participate in choosing appropriate data samples to represent the full range of restoration project deliverables and in soliciting input from the communities of the spill-affected area. Additionally, she would be involved with constructing the graphic user interface, system construction, testing, evaluation, and final report writing.

Julie Michaelson brings expertise in the areas of information management, GIS construction, and metadata documentation. She has acted as principal investigator for several metadata implementation projects for the U.S. Geological Service, Biological Resource Division, for the areas of Prince William Sound/Copper River Basin, Glacier Bay, and the Arctic National Wildlife Refuge. She beta tested the metalite and metamaker software for the documentation of spatial datasets to National Standards. Ms. Michaelson currently provides GIS support for AKNHP and directs the design and construction of the GIS system for the Alaska Biological Conservation Database, which catalogs data on rare species and critical habitats statewide. She provides products for the AKNHP web page from the ARCVIEW and ARCINFO software systems which power the GIS system.

Ms. Michaelson, AKNHP's Database Manager, would act as co-principal investigator for the project. She would be its GIS specialist and participate in choosing sample datasets. She would implement metadata standards for all datasets choosen for the prototype system and be actively involved in the design of and product construction for the graphic user interface. Ms. Michaelson would work closely with the database management staff to implement GIS technologies to

existing spatial databases and help direct Internet product construction. She would also be involved in system design, testing, and evaluation, as well as with final report writing.

OTHER KEY PERSONNEL

Sal Cuccarese, Interim Director of ENRI, would serve as the project's Information Coordinator. He would provide project oversight and would interface with the Trustee Council to assure that the prototype system meets Trustee Council goals. He would also be involved in project evaluation and review. Mr Cuccarese, a senior ENRI scientist, brings decades-long expertise in arctic research and project management. He is knowledgeable of research and information needs from both the scientist's and lay user's perspectives. He has been involved in many projects involving successful communication and delivery of scientific information to diverse audiences, including residents of Alaska's rural communities.

Jerry Tande would be the project's Webmaster. He is currently responsible for the design, construction, and posting of the AKNHP web site and has tremendous expertise in the use of the world wide web as a distribution system for database and GIS products. Mr. Tande is experienced with a variety of web design software packages, as well as wth using the web as a design media. He has geared his designs to a wide variety of users in previous graphic user interfaces. His work tasks would be the design and construction of the web interface system, as well as overall data dissemination system organization.

Julia Lenz, Database Specialist with AKNHP, would act as the Database Management Expert for this project and work closely with Ms. Michaelson. Her expertise involves the transfer of a wide variety of database, spreadsheet, and wordprocessing systems, and she is very familiar with transfer routines needed to accurately utilize the processing power within a variety of software packages. Ms. Lenz's responsibility would be to analyze existing data and massage data as necessary for transfer into a format for intergration. She would also make products from existing datasets Internet ready.

Wanda Seamster, Graphic Artist with ENRI, would provide graphic and mapping services for the project. She would prepare Internet products, as well as design essential components of the graphic user interface. Ms. Seamster specializes in visually translating scientific information into readily understandable formats for diverse audiences, and she has won many local and national awards for her work.

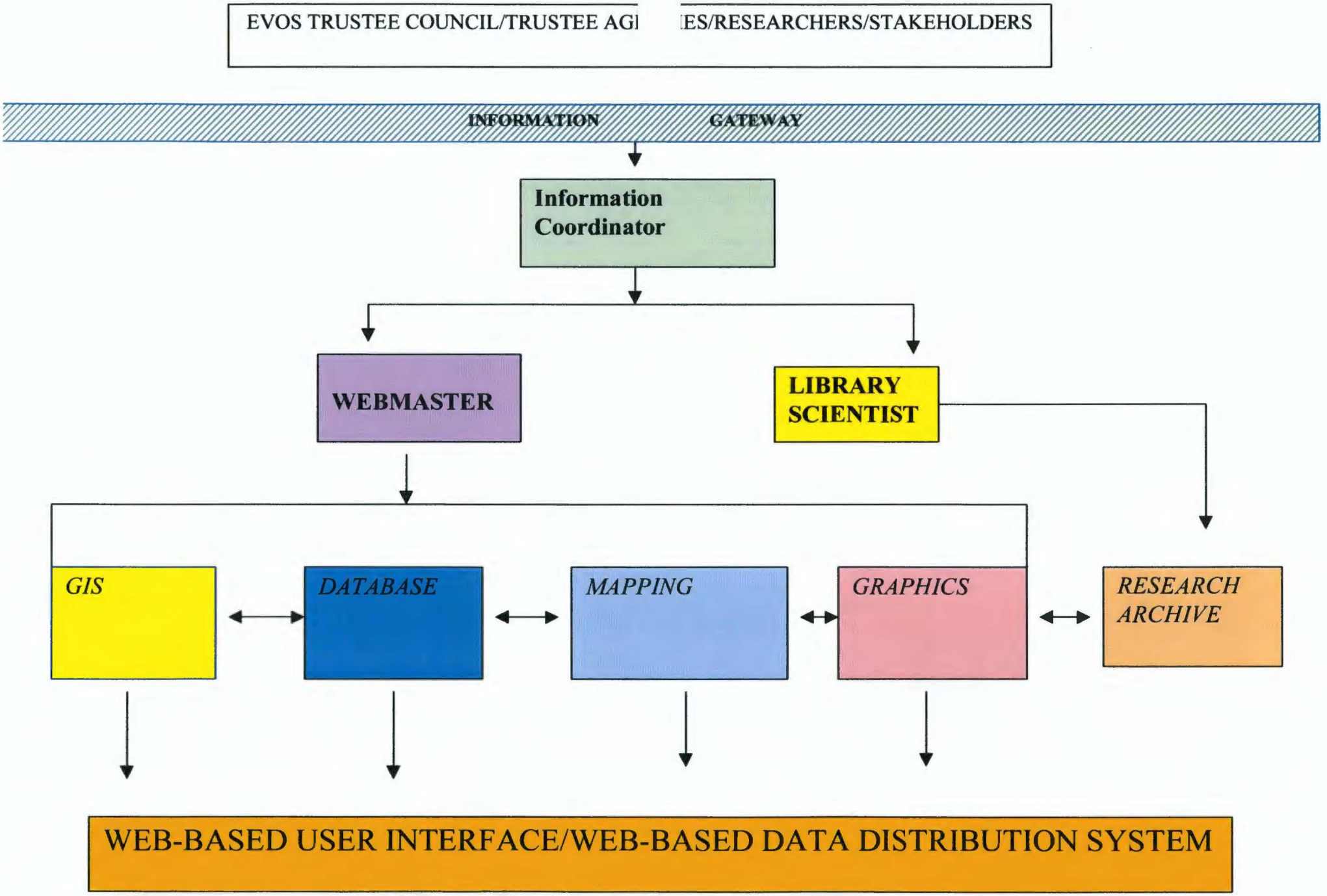
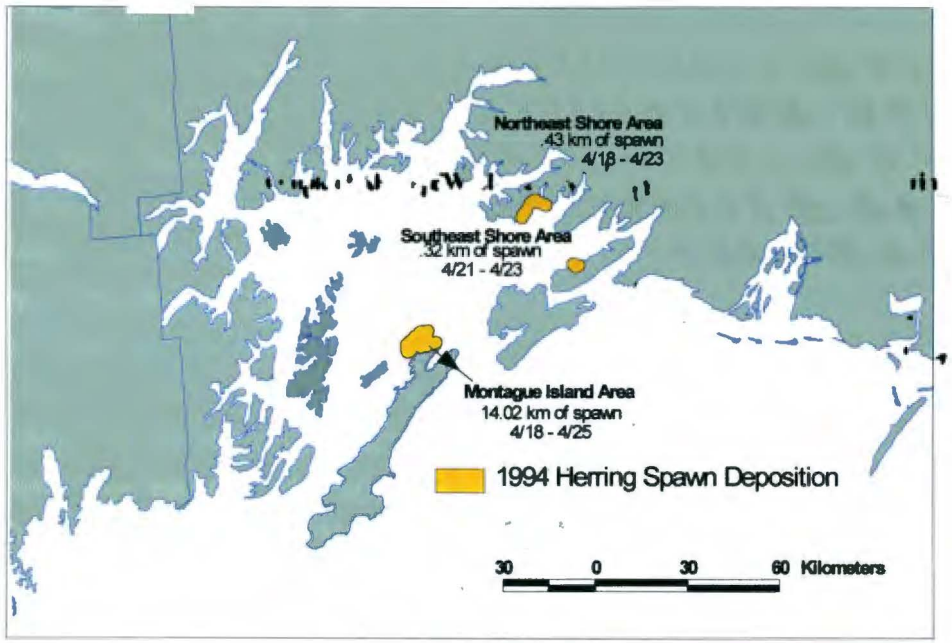
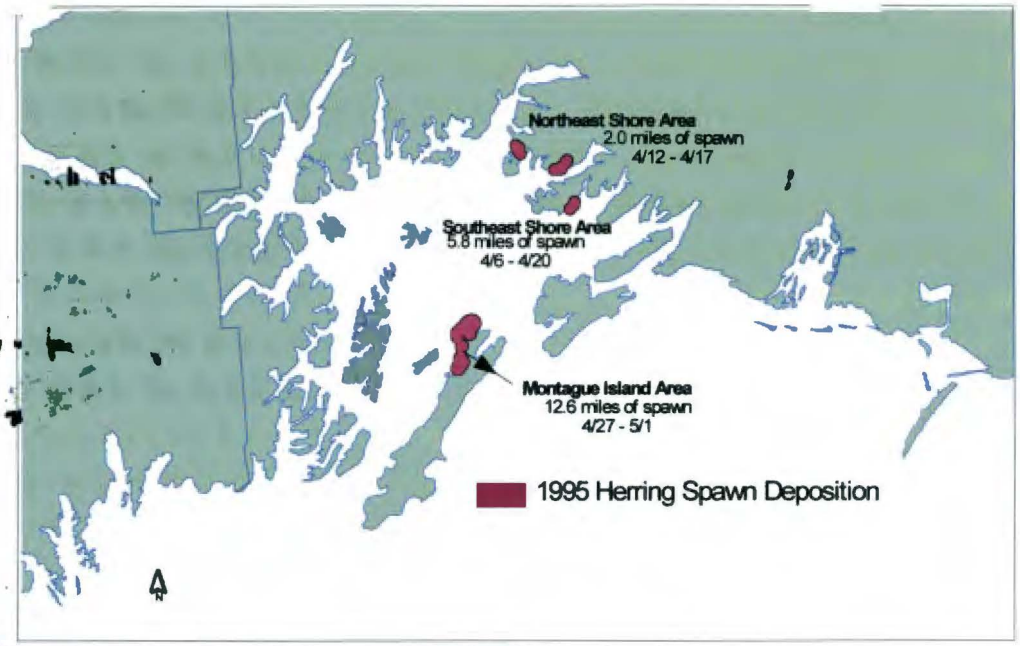


Figure 1. Major Components of the Prototype System





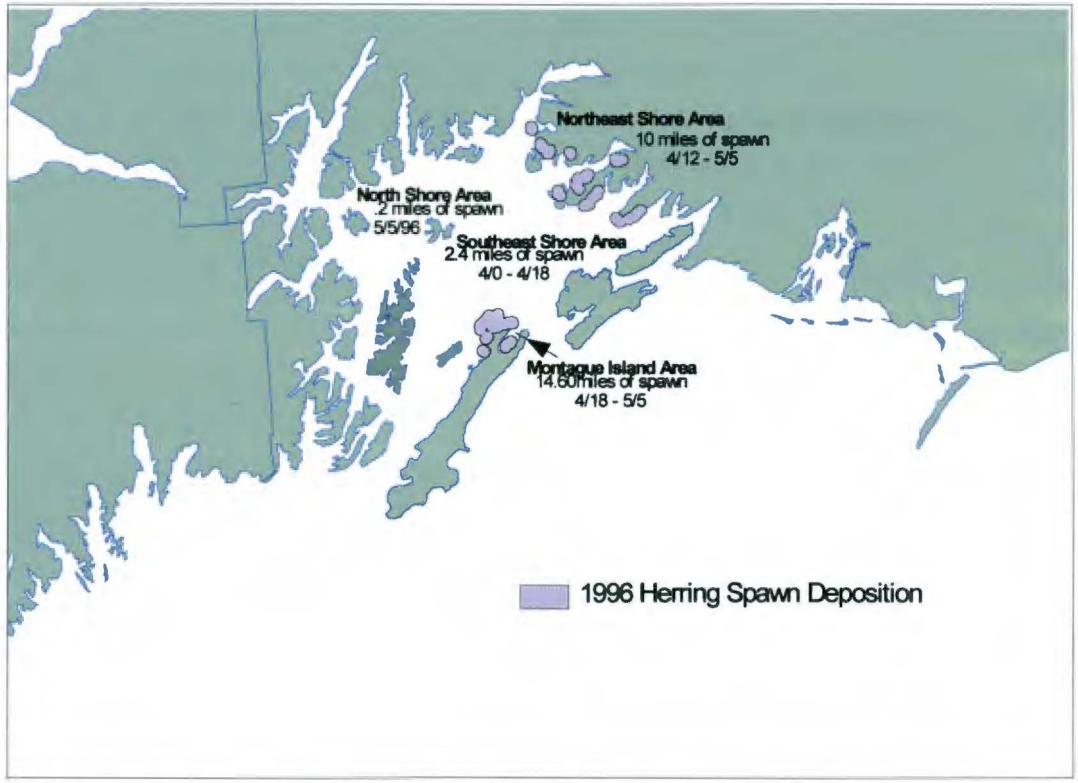


Figure 2. Example of ARCVIEW GIS Layers Showing Prince William Sound Herring Spawn, Shoreline Mileage, and Dates Mapped During ADF&G Aerial Surveys, 1994 - 1996

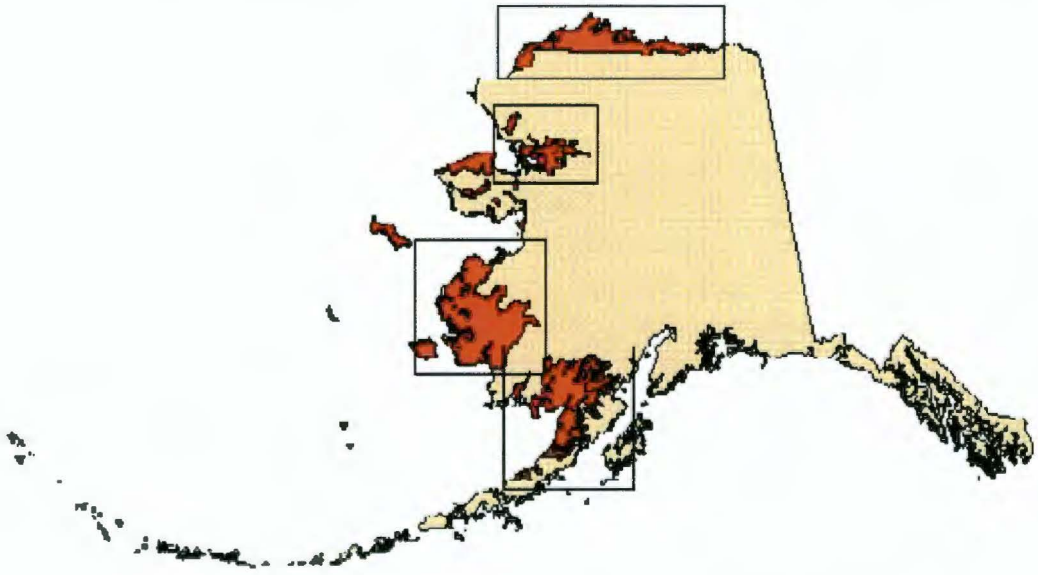
Species of Concern AKNHP

Oldsquaw

Clangula hyemalis

Site Map

Primary Breeding Areas and Islands with documented nesting Oldsquaw in Alaska



Click on a Boxed Area for More Detail

Boxed areas are where USFWS, Migratory Bird Management, Anchorage has completed intensive surveys and density mapping. Areas of lower Oldsquaw density (not shown) occur in the following Waterfowl Production Units: Yukon Flats, Koyukuk, Tanana-Kuskokwim, Nelchina, Innoko, Kenai-Susitna, and Copper Delta (Hodges et al. 1996).

This information constitutes a summary of information collected or compiled by The Alaska Natural Heritage Program, University of Alaska, Anchorage, Alaska. It in its various parts are currently treated as an unpublished file report and its use for any purpose should be cited as follows:

Alaska Natural Heritage Program. 1998. Status Report on the Oldsquaw (*Clangula hyemalis*) in Alaska. Unpub. Rep. on file as reported from the Heritage web site <http://www.uaa.alaska.edu/enri/aknhp_web/index.html>. The Alaska Natural Heritage Program, University of Alaska Anchorage, 707 "A" Street, Anchorage, AK.

Send comments to angft
Alaska Heritage Program
707 A Street, Anchorage, Alaska 99501
Phone (907) 257-2780 Fax (907) 257-2789

[CONTACT US] [SITE MAP] [DATA REQUESTS] [ABOUT AKNHP] [ALASKA BIODIVERSITY] [LINKS TO BIOLOGY RESOURCES]

Figure 3. Example of a clickable map guiding the user to the map below.

Alaska Rare Plant Field Guide AKNHP

Alaska
Rare Plant Field Guide

Robert Lipkin
Alaska Natural Heritage Program
University of Alaska Anchorage

David F. Murray
University of Alaska Museum
University of Alaska Fairbanks

Ill. by D. Collet
1997

This resource is based on the following source:

Lipkin, R. and D.F. Murray. 1997. Alaska rare plant field guide. U.S. Fish and Wildlife Service, National Park Service, Bureau of Land Management, Alaska Natural Heritage Program, and U.S. Forest Service.

This resource should be cited as:

Lipkin, R. and D.F. Murray. 1997. Alaska rare plant field guide. U.S. Fish and Wildlife Service, National Park Service, Bureau of Land Management, Alaska Natural Heritage Program, and U.S. Forest Service. http://www.uaa.alaska.edu/enri/aknhp_web/index.html

---

Figure 4. Example of a PDF-formatted document.

DATE	START_TI	END_TIME	STATION	TRAWL	TRANSECT	TRAWL_DEPT	SHAL_DEE	LATITUDE	LONGITUD	ENDLAT
7-Aug-95	14:08	14:37	94	1	E. of Storey Is.	12	0	60.69218	-147.35141	60.70551
9-Aug-95	21:57	22:22	108	1	N. of Hogan Bay	15	0	60.19290	-147.72176	60.61133
9-Aug-95	19:00	19:14	114	1	Montague Point	20	0	60.38330	-147.06718	60.37738
10-Aug-95	19:59	20:10	114	3	Montague Point	10	0	60.38326	-147.06036	60.37940
10-Aug-95	20:38	21:05	114	7	Montague Point	12	0	60.38700	-147.09520	60.67330
10-Aug-95	12:10	13:02	116	1	Port Gravina	25	0	60.67060	-146.40413	0.00000

Table 1. 1995 Summer Forage Fish Survey - APEX Studies

ENDLONG	DEPTH_CO	POLLOCK	HERRING	SALMON	CAPELIN	EULACHON	PROWFISH	CREST_SC
-147.33998	2	0	0	0	2	0	1	0
-147.45701	2	22	4	1	6	0	2	0
-147.04791	2	0	0	0	16	0	0	0
-147.06036	1	0	0	0	16	0	0	0
-146.39698	2	1	0	0	16	0	0	0
0.00000	2	0	3933	0	1	0	0	0

Table 1. 1995 Summer Forage Fish Survey - APEX Studies

2000 EXXON VALDEZ TR E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$125.9
Travel		$0.0
Contractual		$0.2
Commodities		$1.0
Equipment		$0.0
Subtotal	$0.0	$127.1
Indirect		$31.8
Project Total	$0.0	$158.9
Full-time Equivalents (FTE)		1.8
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		$3.0			

Dollar amounts are shown in thousands of dollars.

Comments:

Indirect Cost: As part of the University of Alaska Anchorage, the Environment and Natural Resources Institute used the 25% indirect cost rate required for EVOS projects (ENRI's negotiated rate is 32.7%).

FY 2001 cost of $3,000 is for the preparation of EVOS final report.

Approximately $3,500 is included for gathering input from local communities.

FY00

Prep 12-Apr-99

Project Number: 00398
Project Title: EVOS Data: A Proposed Archive and Enhanced World Wide Web Dissemination System
Name: Environment and Natural Resources Institute, University of Alaska Anchorage

FORM 4A
Non-Trustee
SUMMARY

2000 EXXON VALDEZ TRI E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2000
	S. Cuccarese	Project Manager	1.0	9.4		9.4
	J. Braund-Allen	Library Scientist	2.3	5.9		13.6
	J. Michaelson	GIS Specialist	5.5	6.3		34.7
	J. Lenz	Database Specialist	5.0	4.5		22.5
	J. Tande	Webmaster	5.0	6.6		33.0
	W. Seamster	Graphic Designer	0.8	6.0		4.8
	A. Saxton	Web Graphics Specialist	0.5	3.5		1.8
	J. Alward	Library Assistant	1.3	3.3		4.3
	L. Imle	Project Assistant	0.5	3.5		1.8
						0.0
						0.0
						0.0
		Subtotal	21.9	49.0	0.0	
					Personnel Total	$125.9

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2000
						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

FY00

Prep 12-Apr-99

Project Number:
Project Title: EVOS Data: A Proposed Archive and Enhanced World Wide Web Dissemination System
Name: Environment and Natural Resources Institute, University of Alaska Anchorage

FORM 4B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRU E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
Communications (postage, telephone, etc.)	0.2
Contractual Total	$0.2

Commodities Costs:	Proposed
Description	FY 2000
Update ARCVIEW Software	0.2
Internet Software Upgrade	0.1
Archival Paper	0.2
Misc. Supplies	0.1
Archival Tapes (video, GIS storage, etc.)	0.3
Computer Diskettes	0.1
Commodities Total	$1.0

FY00

Prep 12-Apr-99

Project Number:
Project Title: EVOS Data: A Proposed Archive and Enhanced World Wide Web Dissemination System
Name: Environment and Natural Resources Institute, University of Alaska Anchorage

FORM 4B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRI E COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
			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
Sun Ultra Workstation	
MacIntosh Computer	
Windows-based PC	
Microsoft Office Software	
ARC/INFO Software	
ARCVIEW Software	
Photo Scanner	
Adobe Illustrator/Pagemaker Software	
Internet Design Software	

FY00

Prep 12-Apr-99

Project Number:
Project Title: EVOS Data: A Proposed Archive and Enhanced World Wide Web Dissemination System
Name: Environment and Natural Resources Institute, University of Alaska Anchorage

FORM 4B
Equipment
DETAIL

Eastern Prince William Sound Human Use and Wildlife Disturbance Model

Project Number:	00399
Restoration Category:	General Restoration & Habitat Protection
Proposer:	Chugach National Forest
Lead Trustee Agency:	USFS
Cooperating Agencies:	ADNR
Alaska SeaLife Center:	No
Duration:	1st year; 3-year project
Cost FY00:	$ 179.1
Cost FY01:	$ 80
Cost FY02:	$ 60
Geographic Area:	Eastern Prince William Sound
Injured Resources/Service:	ALL

ABSTRACT

This project is an expansion of the human-use and wildlife disturbance model developed for the western Prince William Sound (PWS). The project will use geographic information system (GIS) techniques to describe current human-use patterns in eastern PWS and to model potential changes in those use patterns as a result of additional development (e.g., increased access). GIS generated maps of present and projected human-use patterns will be incorporated with GIS maps of the distribution of resources injured as a result of the *Exxon Valdez* oil spill. This will provide a basis to identify areas where there may be existing and potential conflicts between human use and wildlife concentrations resulting in disturbance. Disturbance of injured wildlife may result in decreased productivity exacerbating the effects of the oil spill and prolonging the time to recovery. Identification of potential areas of disturbance will allow development of recommended management practices that may eliminate or minimize the negative effects of increasing human use. All injured resources and subsistence species will be addressed in a general approach but specific management recommendations will be developed for harbor seal, pigeon guillemot and cutthroat trout. The model of projected human-use patterns and resulting management recommendations are expected to be useful to Federal, State, and private land managers in their land management planning efforts.

INTRODUCTION

This project is an expansion of the pilot project (98339) to model human use and wildlife disturbance in Western Prince William Sound. By developing the model for activities in the Eastern PWS a model of the entire sound would be available as a management tool. This proposal is an extension of the original pilot project proposal. The same techniques to develop the model would be applied for the rest of PWS. There are two exceptions. First, the original proposal included a literature review of human disturbance on wildlife. This review would not need to be repeated. Secondly, the pilot project included an emphasis on three of the injured resources. Since the Trustee Council funded the NOAA environmentally sensitive index maps for PWS, these data layers will be applied to the model and more of the injured resources will be covered.

The Prince William Sound ecosystem has experienced many changes in the last decade. The most notable of these is related to the *Exxon Valdez* oil spill (EVOS) of 1989. The EVOS caused direct and indirect effects on many resources throughout the oil spill area (EVOS Restoration Plan). Some of the oil spill effects have resulted in changes in human use patterns in PWS and other areas. For example, subsistence harvest patterns changed after EVOS (Seitz and Fall 1995), and commercial harvest of herring was closed in PWS for several years due to pathological problems believed to be caused by the spill. Land acquisition through the EVOS restoration program has made more land available for public use and habitat protection.

In addition to changes directly linked to EVOS, other changes in human use of PWS are occurring. Tourism patterns in PWS have changed as cruise ships altered their routes and new glacier tour cruises have been added. While the extensive commercial salmon fishery is expected to remain at about the same level, recreational boating and kayaking has increased dramatically in the last decade and is expected to continue to increase (ADOT 1995). Alaska Pacific University professor, Paul Twardock, has been monitoring the kayak use patterns in western PWS since 1988. His data show that kayak use through Whittier has increased by 6 percent per year over the last decade. Additional changes in human use are expected as projects such as the Whittier access road and potential development of Chenega and Tatitlek lands are completed. The Whittier access road will make western PWS much more accessible to Alaska's largest population base and may redirect use that originates in Valdez and Cordova because of crowding. This improved access is expected to result in increased human use in PWS (ADOT 1995).

Increased human activity in PWS may affect the recovery of species injured by EVOS. Human-caused disturbance has been shown to have negative effects on a wide variety of species (e.g. York 1994; Boyle and Samson 1983). Some types of boat-based disturbance have been shown to reduce productivity in many species of birds (e.g. Sowls and Bartonek 1974) and in some seal species (e.g. Richardson et al. 1988). The potential effect of human disturbance varies with species, frequency and type of disturbance, season, and other factors (Knight and Cole 1991). As human use increases in PWS the potential for disturbance-related effects on resources also increases. Human disturbance to marine mammals, seabirds, and shorebirds often occurs as people approach for viewing or photos or when beach activities such as camping and hiking disturb nesting birds.

Managing human use in large geographic areas is often very complex; management of PWS is the responsibility of numerous State and Federal Agencies, and private landowners. Presently, there is no single source of information on human use in PWS. This may create difficulties in resource management if human use increases as predicted and populations of injured resources are affected by human disturbance.

This project provides a foundation for displaying and understanding existing and future human use patterns in PWS, the potential disturbances on injured resources, and would make recommendations for management actions to minimize adverse effects of increased human use on injured resources. This proposal would expand the on-going pilot project in western PWS to include the entire PWS. The project consists of three components:

1. Describe existing human use patterns in PWS through computer simulations, and

2. Develop a model to project changes in human use patterns as a result of development and management actions in PWS

3. Display these human use patterns over environmentally sensitive areas.

The final product of this project will be a report with management recommendations for State and Federal agencies and a geographic computer database. The report and computer model will be available to agencies and to PWS communities to assist land owners and managers to better understand the potential human use of an area and make appropriate management decisions.

This project will provide a useful tool in many aspects of the EVOS restoration program. The model will help in the identification of appropriate research and monitoring sites to understand the effects of human disturbance on specific injured resources or services. It will assist Alaska Department of Natural Resources on evaluating the effects of proposed developments in Eastern PWS. It will help in identifying areas where subsistence harvests may be affected by increased recreation and other uses. In addition to benefiting restoration activities, the model and recommendations will benefit State and Federal agencies, and the various Alaskan Native Corporations, in land management planning and in the protection of resources.

NEED FOR PROJECT

A. Statement of Problem

Human activity in PWS is expected to increase significantly in the next decade (ADOT 1995). This project provides a management tool that will increase the effectiveness of management of resources and human use in PWS. The project has direct application under Habitat Protection and General Restoration as described in the EVOS restoration plan (EVOS Trustee Council 1994), and has the potential to aid in the restoration of most of the identified injured resources and services. The pilot phase of this project placed an emphasis on describing potential disturbance effects and developing management recommendations for harbor seals, pigeon guillemots, and cutthroat trout on public lands in PWS. This project will incorporate all injured species if the NOAA maps of PWS environmentally sensitive areas are updated. By expanding

the modeling effort to the eastern PWS, areas in the Sound that receive use from Valdez and Cordova, as well as Whittier, will be more accurately represented than in the pilot project which addressed only Whittier and Chenega Bay as access points.

B. Rationale/Link to Restoration

The Trustee Council has made significant progress in understanding the effects of the EVOS and in restoring and protecting the resources and services injured by the spill. However, the recovery of these resources and services may be affected by a dramatic increase in human use in PWS. The ADOT has predicted that the Whittier access road will result in an increase of over 600% in recreational and tourism boat traffic in parts of western PWS by the year 2015 (ADOT 1995). However, the Whittier road is one of several changes that will affect human use in PWS. For example, new cruise lines have incorporated Cordova onto their schedules and permits for float house businesses are increasing in eastern PWS. As more people recreate and work in PWS, there will be higher levels of interactions between people and injured resources. Research has shown that human disturbance can cause a wide range of problems for wildlife and fish populations. At its most severe levels, disturbance can cause mortality or reduced productivity (Knight and Cole 1991). As human use increases in PWS, the potential for problems related to human disturbance to delay recovery of injured species also increases. By identifying existing and potential human use patterns in PWS, the Trustee Council would be providing a tool that would assist in habitat protection, general restoration, and would also provide valuable information for research and monitoring projects.

C. Location

By expanding the pilot project to include the eastern PWS, the entire PWS will be modeled. The project will benefit all State and Federal agencies with management responsibilities in PWS. The project will also benefit other landowners, especially the Tatitlek, Eyak and Chugach Alaska Corporations and the community of Tatitlek.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Involvement from PWS communities is an important component of this project. In order to fully understand human-use patterns in PWS, the human use patterns to and from each village must also be incorporated into the model. The communities would be asked to participate in describing human-use patterns around their communities. After presenting preliminary results from the western PWS human use modeling project, we were approached by a member of the Valdez Community council seeking information out of Valdez. This interest indicates that we are likely to have the same enthusiastic support from individuals and businesses in Valdez and Cordova that we had in Whittier.

PROJECT DESIGN

A. Objectives

There are two objectives associated with this project:

1. Describe existing and potential human-use patterns in eastern PWS;

2. Identify areas where human disturbance has a high potential to affect injured resources.

B. Methods

These methods are similar to those described in the original proposal for project 98399, except for discussion on a literature review of wildlife disturbance. This proposal also covers two primary transportation origin points (Cordova and Valdez) while the original proposal incorporated one primary origination point.

Description of Current Use Patterns

Water-based transportation and aircraft will be considered in the description of human-use patterns in PWS. For water-based use, vessel classes will be established to more accurately describe use patterns. Classes will be based primarily on size and function (e.g., kayaks and other personal pleasure craft, charter, tour, commercial fishing). Current number, locations, and trips of vessels by class in eastern PWS will be determined through registration records, fuel records, and harbor master information on slip rental, moorage and launches. Additional information will be provided through user surveys.

The extent of human use in PWS will be described through an analysis of the distribution of water craft and aircraft in association with preferred destinations (e.g., recreational and commercial fishing areas, mooring buoys, camping sites, recreation cabins). Distribution of use will be determined through survey information and records of use by charter operators. "Preferred" destinations will be described from existing information such as recreation sites maintained by land management agencies (e.g., U.S. Forest Service, Alaska Department of Natural Resources), commercial fishing areas (e.g., Alaska Department of Fish and Game, Prince William Sound Aquaculture Association), sport fishing areas (e.g., Alaska Department of Fish and Game), and tour destinations (e.g., tour operators associations). Potential use levels of these sites will be determined from a mail surveys of the patrons of the Cordova and Valdez harbors and air charter operators. The surveys will be distributed to individuals and groups known to work and recreate in PWS. These surveys will help to refine model parameters on frequency and duration of trips associated with different vessel classes.

Cell-based modeling using the GRID feature of the ARC/INFO GIS will form the basis of our approach to evaluate human-use patterns in western PWS (Environmental Systems Research Institute, Inc. 1994). Weighted distance functions will be used to describe areas that are available to and may be used by vessel operators. Separate grids of the water portion of PWS will be created for the analysis of dispersion of vessels in each class. For each vessel class a source grid will be created to represent trip initiation points (e.g., marinas, launch sites). The

COSTDISTANCE function will be used to determine the minimum accumulative-travel cost from the source through each cell on the grid to a specific destination on the grid. This function allows for the control of factors that influence movement of water vessels. First source cells will be identified. Then the cost to travel to each neighbor that adjoins a source cell will be determined. Next, each of the neighbor cells will be ordered from least costly to most costly. The cell location with the least cost will be removed. Finally, the least-accumulative cost to each of the neighbors of the cell just removed will be determined. This process will be repeated until all cells on the grid have been assigned an accumulative cost to reach a specific destination.

Corresponding cost grids will also be established for each vessel class. A cost grid will assign an impedance value to each cell that reflects choices involved in moving through any particular cell (e.g., avoidance of open water, avoidance of navigation risks). The value of each cell in the cost grid will represent the ease of a particular vessel type in passing through the cell, (Environmental Systems Research Institute, Inc. 1994:253). Each cell location will be given a weight proportional to the relative cost incurred by a vessel passing through a cell.

ARC/INFO GRID functions will be used to create grids that represent dispersion of water craft by vessel class in eastern PWS. These dispersion grids for each vessel class will be combined through map algebra to describe density of use in eastern PWS by use class (e.g., low, medium, high vessel densities). The dispersion and density grids will be combined with grids of sensitive areas for injured species to identify those areas where conflict may occur.

These initial grids will provide representations of movements and concentrations of water vessels in the study area. This information will be used to initially characterize areas of PWS as having high, medium, and low densities of vessels by vessel class and total vessels on a monthly basis. Separate grids will be constructed for each month from May through September. Actual vessel densities in representative areas will be determined, by month, through field surveys.

A stratified random sampling method will be used to select areas throughout Eastern PWS where aerial surveys will be conducted to evaluate and refine representations of current use patterns. Counts of vessels present in each of the sample areas will be made each month from June through September during high-use (e.g., weekends) and low-use (e.g., mid-week) periods. Counts will be conducted from fixed-wing aircraft; all vessels observed during flights within the sample areas will be recorded by vessel-class. Most vessels within sample areas are anticipated to have high sightability. However, small, nonmotorized vessels (e.g., kayaks) may not be obvious to the observers, especially if they are near the shoreline. Simultaneous surveys from aircraft and boats will be conducted in areas of each of the density classes during June, July, and August to help quantify sightability factors for the aerial surveys.

Results of the field surveys will be used to determine if ranges of actual vessel densities in the sample areas correspond to the vessel density classes represented in the dispersion grids under current conditions. If vessel densities are not corroborated by the results of the field counts, use patterns will be examined and modified to bring the dispersion grids into compliance with field counts.

Model Development

Upon completion of the dispersion grids describing current use patterns, a model will be

developed to estimate future use of PWS under potential management changes (e.g., improved access, additional fuel sources provided). The relationship of current use patterns to factors associated with dispersion (e.g., distance from port; proximity to camp sites, fishing areas, scenic areas; availability of fuel) will be analyzed through multivariate techniques. The resulting best-fit model will be used to predict future use of PWS. Information from the user surveys and from the literature will be used to modify model variables to project future use under varying development scenarios. Analyses will be completed which will incorporate projections of increased use of eastern PWS to demonstrate expected temporal and spatial changes in use patterns. ARC/INFO grids of the resulting potential human-use patterns will be combined with existing GIS maps of the distribution and areas of essential habitat for injured wildlife and fish resources. Areas of potential conflict (e.g., high-density human-use areas coinciding with essential habitat) will be identified.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Forest Service personnel will be responsible for the development and evaluation of the current human use patterns. Evaluation and modification of dispersion grids will be based on the results of field surveys. Development of the future-use model will be based on the current human-use patterns and expected responses to development scenarios. The Forest Service will apply the results of the previous literature search on human disturbance effects on injured resources, and develop management recommendations in cooperation with the State. Forest Service personnel will incorporate the model with known information for injured species. Coordination with other agencies will be the responsibility of the Forest Service.

The State of Alaska, Department of Natural Resources (ADNR) is a partner on this project. The Chugach National Forest, ADNR, and Tatitlek, Eyak and Chugach Alaska Corporations are responsible for most land management within the study area. An ADNR Natural Resources Manager will provide input and coordination with the Division of State Parks and Outdoor Recreation, and the Division of Lands. This partnership would ensure that relevant State activities are included in the model, and that the management recommendations are compatible with State management responsibilities. The State will also conduct the user surveys, and incorporate results of previous surveys, to refine the information about existing use patterns and to provide the basis for future use patterns.

Contracts for this proposal include airplane costs associated with conducting the aerial surveys. Tatitlek, Eyak and Chugach Alaska Corporations would be asked to collaborate on this project by working with the principal investigators to ensure that the human use model accurately displays existing activities on Corporation lands and activities associated with the different communities.

SCHEDULE

A. Measurable Project Tasks for FY00

Oct. 1–December 1:	Design and distribute user surveys, begin data collection, and determine appropriate destination points

December 1– April 30:	Collect human-use activity data, analyze user survey results, develop GIS layers of current use patterns
January:	Attend EVOS conference
May 1 - Sept. 30:	Collect field data (aerial surveys) on dispersion patterns associated with current use data, complete draft existing use model

B. Project Milestones and Endpoints

Both of the objectives described in this proposal will be fully completed at the end of the project in April 2002. Project milestones are described in the following schedule.

FY00

Oct. 1–December 1:	Design and distribute user surveys, begin data collection
December 1– April 30:	Collect human-use activity data, develop GIS layers of current use patterns, and analyze user survey data
January:	Attend EVOS conference
May 1- Sept. 30:	Collect field data on dispersion patterns associated with current use

FY01

Oct. 1 – January 1:	Modify GIS layers of current use patterns based on field data, develop model to predict future use patterns.
January 1 - February 28:	Apply the model to predict future patterns of use Prepare preliminary results for presentation at the annual EVOS symposium.
March 1 - May 31:	Continue predictive model, assemble information on sensitive areas for injured resources
March 15 – April 15:	Prepare annual report
June 1 - August 31:	Evaluate current and projected human-use patterns relative to sensitive areas for injured resources
Sept. 1 - Sept. 30:	Begin development of management recommendations

FY02

Oct. 1 – April 15:	Finalize model; prepare final report; prepare manuscripts for publication

C. Completion Date

This project will be completed by April 15th, 2002. This includes a final computer model. This does not include development of a user-based version of the dispersion model for direct use by land managers.

PUBLICATIONS AND REPORTS

Annual progress reports will be submitted in April 2001. The final report for this project will be submitted in April 2002. Manuscripts will be prepared for journal publication in FY02, we anticipate two manuscripts will be submitted.

PROFESSIONAL CONFERENCES

The principal investigators will request support to present the model at annual GIS and The Wildlife Society conferences in FY01 or FY02.

NORMAL AGENCY MANAGEMENT

This project is outside the scope of normal management for the Chugach National Forest. Development of human dispersion models similar to the proposed project has not been done previously in the context of National Forest management. The Forest Service has conducted public use surveys in 1992 and 1995 on the Chugach National Forest to provide information for the Forest Plan Revision process. Additional surveys are not planned for PWS. This project is also outside of normal agency management because of the combination of species being addressed. Populations of species injured by the EVOS are potentially some of the most vulnerable to disturbance associated with increased human use. Many of these species, such as harbor seals, rarely occur on National Forest land; however, activities and management associated with National Forest land can affect these marine species.

Ultimately, managing human use in PWS will be an interagency responsibility which will require coordination between multiple agencies. This project will provide useful information for all of these agencies.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Opportunity exists to integrate this project with many of the other restoration projects. If the NOAA Environmentally Sensitive Area maps for PWS are updated in FY99, those GIS layers would be merged with the complete human use model for PWS. This combination would be important information in the management of these sensitive areas for the recovery of injured resources and services.

The project would also be integrated into State and Federal agency management and would provide useful information to the Alaskan Native Corporations and local communities in their ecotourism development plans for PWS. The model and recommendations would also benefit resource managers who make project-level decisions for the Chugach National Forest and for the Alaska Department of Natural Resources. Many of these individuals would be involved in the development of this project and would have the opportunity to apply the information to other aspects of land management. It is anticipated that other Federal agencies, such as National Marine Fisheries Service, would benefit from this project in their management activities.

The Alaska Department of Natural Resources is a partner on this project. This partnership will ensure that activities undertaken by State agencies are incorporated into the model and that the product would be beneficial to the State of Alaska.

PROPOSED PRINCIPAL INVESTIGATORS

Karen A. Murphy
Chugach National Forest
3301 C Street Ste 300
Anchorage, AK 99503
(907) 271-2286
(907) 271-3992(FAX)

Lowell H. Suring
Chugach National Forest
3301 C Street Ste 300
Anchorage, AK 99503
(907) 271-2836
(907) 271-3992 (FAX)

PRINCIPAL INVESTIGATORS

Lowell H. Suring

Lowell H. Suring received his M.S. in wildlife science from Oregon State University in 1974. His thesis involved assessing habitat use and activity patterns of the endangered Columbian white-tailed deer. This work lead to co-authorship of two major scientific publications. Lowell was leader of the Endangered Species and Wildlife Biometrics units in New York State from 1974 through 1977. In 1977 and 1978 he conducted research on secondary succession patterns in pinyon-juniper woodlands in northwest Colorado. From 1978 to 1984 Lowell held biologist positions with the Fish and Wildlife Service and Forest Service in New Mexico and Minnesota where he was involved with determining wildlife habitat relationships and the assessment of effects of management actions on wildlife habitats and populations. Since 1984, Lowell has been a primary participant in the development of GIS-based wildlife habitat relationships and cumulative effects models in the Alaska Region of the Forest Service. Lowell's professional expertise and interests focus on analyzing habitat-use patterns of wildlife and the development and application of computer-based habitat assessment techniques. He has authored or co-authored more than 30 technical and semi-technical articles describing accomplishments in these areas. Currently, Lowell is employed by the Chugach National Forest where he is implementing analytic techniques and tools that may be used to evaluate the capability of habitats to support wildlife and the effects of land management activities on habitat capability. To support these efforts he has had extensive training and experience in the application of ESRI's ARC/INFO geographic information system. Lowell will have primary responsibility in development of the human use dispersion model.

Karen A. Murphy

Karen Murphy received a Masters in Environmental Management from Duke University in 1995. Her thesis emphasis was on applying decision theory and risk assessment to wildlife management. Karen has extensive experience with fish and wildlife management on the Chugach National Forest. She began working in Alaska in 1984 as a biological technician responsible for conducting field surveys and monitoring in PWS, Copper River Delta and other areas of the Chugach National Forest. In 1991, she began working with the EVOS Restoration Planning Work Group. She participated in the development of the EVOS Restoration Plan and companion EIS. Since 1996, Karen has been the wildlife biologist for the Glacier Ranger District which covers western PWS and Turnagain Arm. Her current position, combined with her EVOS experience will enhance the opportunity to integrate this project with other EVOS projects and to apply the results to wildlife management on the Chugach National Forest. Karen will have primary responsibility for administering and coordinating this project and for the development of management recommendations.

OTHER KEY PERSONNEL

Ali Iliff, Natural Resource Manager with ADNR will represent the State Marine Parks and State Lands on this project. She will also work with ADF&G and other state agencies to incorporate appropriate data into the model.

Dan Logan, Wildlife Biologist, with the Cordova Ranger District (USFS) will assist in acquiring information for this project. He is a long-time resident of Cordova and has the local knowledge and network needed to expand this model to the eastern PWS.

LITERATURE CITED

Alaska Department of Transportation and Public Facilities. 1995. Whittier access project, revised draft Environmental Impact Statement and revised draft Section 4(f) Evaluation, May 1995. FHWA-AK-EIS-94-02-DR

Boyle, S.A., and F. B. Samson. 1983. Nonconsumptive outdoor recreation: an annotated bibliography of human-wildlife interactions. U.S. Fish and Wildl. Serv. Special Scientific Report Wildlife 252. 113pp

Environmental Systems Research Institute, Inc. 1994. Cell-based modeling with GRID. Environ. Systems Res. Instit., Inc., Redlands, Calif. 481pp.

Knight, R. L. and D. N. Cole. 1991. Effects of recreational activity on wildlife in wildlands. Trans. N.A. Wildl. and Nat. Res. Conf. 56:238-246.

Richardson, W. J., C.R. Greene Jr., C. I. Malme, and D. H. Thomason. 1995. Documented disturbance reactions. Pages 241-322 *in* Marine Mammals and Noise. Academic Press. San Diego.

Seitz, J. and J. A. Fall. 1995. Chapter V: Tatitlek and Chenega Bay. Pages V-1 to V-104 *in* J.A. Fall and C.J. Utermohle, editors. An investigation of the sociocultural consequences of outer continental shelf development in Alaska. II. Prince William Sound. OCS Study MMS 95-011, Tech. Rep. No. 160. Cooperative Agreement No. 14-35-001-30622

Sowls, L. W., and J. C. Bartonek. 1974. Seabirds-Alaska's most neglected resource. Trans. N. A. Wildl. and Nat. Res. Conf. 39:117-126.

York, D. 1994. Recreational-boating disturbance of natural communities and wildlife: an annotated bibliography. USDI-NBS. Biol. Rep. 22. 30pp.

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000	PROPOSED FY 2000 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
					$50.1	$129.0		
Personnel	$0.0	$104.7						
Travel	$0.0	$7.4						
Contractual	$0.0	$46.5						
Commodities	$0.0	$1.5						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$160.1			Estimated FY 2001	Estimated FY 2002		
General Administration	$0.0	$19.0						
Project Total	$0.0	$179.1			$80.0	$60.0		
Full-time Equivalents (FTE)	0.0	1.7						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0			$0.0	$0.0		

Comments:

FY00

Prepared:

Project Number: 00399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Lead Agency: USFS

FORM 2A
MULTI-TRUSTEE AGENCY SUMMARY

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$68.4
Travel		$5.5
Contractual		$40.5
Commodities		$1.5
Equipment		$0.0
Subtotal	$0.0	$115.9
General Administration		$13.1
Project Total	$0.0	$129.0
Full-time Equivalents (FTE)		1.1

LONG RANGE FUNDING REQUIREMENTS

		Estimated FY 2001	Estimated FY 2002		

Dollar amounts are shown in thousands of dollars.

Other Resources								

Comments:

FY00

Prepared:

Project Number: 00399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Agency: USFS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
						0.0
Karen Murphy	Wildlife Biologist	GS11	4.0	5.3		21.2
Lowell Suring	Wildlife Biologist	GS12	3.0	6.4		19.2
Dan Logan	Wildlife Biologist	GS11	1.0	5.6		5.6
Karin Preston	GIS Technician	GS11	1.5	5.3		8.0
Linda Kelly	GIS Technician	GS9	1.5	4.5		6.8
unknown	Biological Technician	GS7	2.0	3.8		7.6
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		13.0	30.9	0.0	
					Personnel Total	$68.4

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
RT Anchorage - Cordova	0.5	6	3	0.2	3.6
RT Anchorage - Valdez	0.5	3	2	0.2	1.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5.5

FY00

Prepared:

Project Number: 00399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Agency: USFS

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed FY 2000
Description	
Aerial Survey Contract	30.0
Boat Charter (3 trips - 3 days each) @ 1K/day	9.0
air charter to Tatitlek	1.5
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$40.5

Commodities Costs:	Proposed FY 2000
Description	
miscellaneous supplies	1.5
Commodities Total	$1.5

FY00

Prepared:

Project Number: 00399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Agency: USFS

FORM 3B
Contractual & Commodities DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
			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

FY00

Project Number: 00399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Agency: USFS

FORM 3B
Equipment
DETAIL

Prepared:

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$36.3						
Travel		$1.9						
Contractual		$6.0						
Commodities		$0.0						
Equipment		$0.0						
Subtotal	$0.0	$44.2			Estimated FY 2001	Estimated FY 2002		
General Administration		$5.9						
Project Total	$0.0	$50.1						
Full-time Equivalents (FTE)		0.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY00

Prepared:

Project Number: 00399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Agency: ADNR

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
Ali Iliff	Natural Resource Office II		2.5	6.5		16.3
Kathryn Reid	Natural Resource Officer 1		3.0	4.5		13.5
unknown	Park Ranger 1		1.5	4.3		6.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		7.0	15.3	0.0	
					Personnel Total	$36.3

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
					0.0
RT Anchorage - Valdez	0.5	3	2	0.2	1.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.9

FY00

Prepared:

Project Number: 00399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Agency: ADNR

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRU! COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed FY 2000
Description	
print and mail user surveys (includes postage to mail to everyone in Valdez and Cordova)	6.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$6.0

Commodities Costs:	Proposed FY 2000
Description	
Commodities Total	$0.0

FY00

Prepared:

Project Number: 00399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Agency: ADNR

FORM 3B
Contractual & Commodities DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
			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

FY00

Project Number: 00399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Agency: ADNR

FORM 3B
Equipment
DETAIL

Prepared:

Metadata For The Exxon Valdez Restoration Archive

"Submitted Under the BAA"

Project Number:	00400
Restoration Category:	
Proposer:	Glenn P. Brooks
Lead trustee Agency:	
Cooperating Agencies:	
Alaska Sea Life Center:	No
Duration:	1 st year, one year project
Cost FY 00:	$48,884
Cost FY 01:	N/A
Cost FY 02:	N/A
Geographic Area:	Prince William Sound, Kenai Peninsula, Kodiak, Anchorage
Injured Resources:	Subsistence, Commercial Fishing, broad application to Injured Resources categories.

ABSTRACT:

This project develops creates Metadata for all existing Trustee Council sponsored research and restoration activity. Metadata content standards will also be established to ensure future compatibility with mandated Federal metadata requirements enacted in response to Executive Order Number 12906, dated June 1994, and implemented through the Alaska Geospatial Data Clearinghouse in 1996. Metadata training and orientation sessions will be offered to the public. Project results will include a spatially referenced framework in which oil spill data will be more easily identified, queried, and used by the public.

INTRODUCTION

The project proposes completion of a *metadata description* of all research and restoration data compiled by Exxon Valdez Trustee Council to date.

The Trustee Council maintains one of the premier, comprehensive collections of oil spill related research in the world. Yet virtually the entire collection is maintained in a dated, traditional format. Virtually no data in the Trustee collection is available via the internet. This proposal is designed to address the rapidly growing need for direct electronic access to this important legacy data collection.

Metadata describes and verifies the structure of electronic data. Metadata format allows original project information to be examined and revised as future changes modifications or additions are made to existing data sets. This project design describes 1995 mandated federal standards for metadata completion, and a methodology for acquiring, publishing and disseminating content in digital form. Completion of the project will provide the Trustee Council, the Alaska Resources Library and Information Services (ARLIS), interested Alaskans and the world scientific community with an internationally recognized, standard descriptive format for querying, evaluating, validating, searching and synthesizing the large volume Trustee Council research and data published since the oil spill.

A final report will include a complete metadata description for each major data set contained in the Trustee Council archive. This project will result in a standardized framework for referencing and synthesizing the broad scope of data collected to date.

NEED FOR THE PROJECT

A. Statement of Problem

The Exxon Valdez Oil Spill Trustee Council has successfully funded and coordinated an intensive, ten year, 180 million dollar research and restoration effort to repair ecological, cultural and societal damage caused by 1989 Exxon Valdez Oil Spill. All scientific reports, articles and damage assessments are now cataloged in a world class, centralized oil spill repository maintained for the Trustee Council by the Alaska Research Library Information Center (ARLIS), located in Anchorage, Alaska. The council estimates in its 1999 annual report, that scientific knowledge about the Prince William Sound ecosystem has been advanced 50 years because of this research effort. However, access and distribution for this important body of data is becoming increasingly limited because of the traditional medium in which the research collection is presented.

The Trustee Council's scientific archive includes over 300 final reports and over 220 natural resource damage assessments arising from study of the Exxon Valdez oil spill. The archive is expected to grow with the completion of additional project work in the next two years. Synthesis of existing research may add significantly to this existing body of data. Study History pages of recently submitted final reports provide excellent summaries of information, and may provide a transitional key to the creation of a true metadata format. However, the archive itself remains ill-suited for electronic discovery.

Nearly all final reports describing scientific findings submitted to the Trustee Council have been submitted in traditional written form. In many instances database summaries are retained only on paper. The research collection as a whole remains accessible only by personal visit to an ARLIS repository, or through special request via interlibrary loan. Select repositories of information exist in several places in the lower 48 but are not well publicized. Informational copies of individual reports no longer exist with many State or Federal agencies; agency collections having been transferred and centralized with the multi agency repository. Also existing data sets often contain cryptic, abbreviated attribute descriptions having vague and ill defined meaning. Staff changes, promotions, retirements and the passage of time are gradually degrading first generation recollection of nuances and long term usefulness of data sets. Metadata preserves that knowledge.

Virtually no data in the Trustee collection is available via the internet. Oil spill related web sites contain database capabilities limited to bibliographic notations or static, short program summaries. Few search engines contain actual references to Trustee Council research materials. This is largely caused by the absence of user defined metadata, a cataloging tool established at the Federal level by executive order in 1994, and implemented in Alaska in 1996. Metadata content creates the ability to publish on-line scientific references in either Federal or State geospatial data clearinghouse programs. The Trustee Council research archive collection has not yet been configured to take advantage of this valuable Internet query and research option.

The result is a well administered, centralized, world class, scientific record of research and restoration; yet some what limited and expensive in its distribution and electronically isolated from increasingly large scale public and scientific access.

B. Rationale/Link to Restoration

Metadata will help Alaskan citizens better understand the nature and significance of the scientific literature archived in 15 community and regional libraries throughout the state.

Metadata will provide a comprehensive guide to that complex and voluminous collection of data. Metadata is rapidly becoming the modern international standard for defining repositories of data. Complete metadata information is now federally mandated for all federal research and data collection projects. As a result metadata is becoming increasingly important as a tool for defining, finding and examining research publications.

Preparation of metadata for the existing archive will greatly enhance public and scientific access to the collection as it expands. Preparing a Trustee Council metadata standard today while the collection still resides in memory of first generation researchers and archivists will result in significant cost savings later. Also, as preparing metadata is the required first step in posting data to the National Geospatial Data Clearinghouse, developing a metadata project in 1999 will allow the Trustee Council to lay a foundation for discussing and planning the future development of publicly available, on-line access to its body of research.

C. Location

Archival research to be conducted in Anchorage and University of Washington reference library, Seattle.

Metadata information and training sessions and follow up archival activity will be conducted as appropriate in Seward, Homer, Cordova, Kodiak and Anchorage.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Communities affected by this project will be informed about metadata and asked to distribute informational brochures through public sources. Paper and e-mail correspondence will be sent to native groups, fishing organizations, community organizations, and natural resources agencies for the purpose of requesting re-publication in periodic newsletters. These same user groups will be asked to disseminate metadata concepts and final products to their membership.

I would hope to work closely with ARLIS staff, interested rural community coordinators, school administrators, and public librarians to raise awareness of metadata concepts and to promote its effective use when searching Trustee Council materials.

Specific informational goals are to:

- Coordinate with the Alaska Geographic Data Committee to post completed Trustee Council metadata in the Alaska Geospatial Data Clearinghouse (AGDC), and the National Geospatial Data Clearinghouse (NGDC).

- Develop public interest news releases for publication in rural Alaskan newspapers, two west coast commercial fishing journals, and the Alaska Journal of Commerce.

- Present opportunities for public metadata training sessions with the staff of ARLIS, the Alaska Sealife Center, and the Kachemack Bay Ecological Characterization Project, the Cordova Public Library, and the Kodiak Marine Science Center.

- Invite interested attendees from outlying spill impacted villages and communities to attend metadata training sessions.

- Provide metadata training opportunities for staff and community facilitators working with the Chugach Regional Resources Council.

Metadata training opportunities may be undertaken directly by personal presentation, or in a grass roots train-the-trainer role with local staff and /or interested citizens from outlying communities willing to participate in at least three additional metadata orientation sessions in their home community. Attendance, travel and transportation costs for trainers are not included as a cost in the attached budget estimate.

Any contact and/or referral of information to traditional ecological knowledge providers will be in accordance with the Alaska Federation of Native policy and guidelines regarding TEK respondents.

This metadata project will be highly beneficial for rural Alaskans, subsistence users, natural resource managers, the commercial fishing industry, teachers and students in Alaska's public school system, and university students and researchers interested in accessing Exxon Valdez Oil Spill datasets over the Internet.

This project will also benefit those interested in synthesizing the existing written record, by helping people find data they need and by helping people determine how to use it.

At the conclusion of this project, students will have ready access to a well rounded picture of each specific research project, where it occurred, and what relevance it may have to other restoration data sets and to their own lives.

PROJECT DESIGN

A. Objectives:

Four objectives guide this project:

1) Develop metadata content and format for converting legacy data to a spatial referenced index.

2) Provide wide spread dissemination of current oil spill metadata and a means for interrupting that data directly into the hands of the public.

3) Equip ARLIS archives with a timely, complete, metadata description of all Trustee Council related data sets

4) Prepare Trustee Council research archives for inclusion in Federal and State Geospatial Data Clearinghouses.

B. Methods

The project will conclude in three phases: development of comprehensive metadata for each published research project; compilation and preparation of metadata in digital format; and distribution of metadata content for posting to the World Wide Web.

Developing Comprehensive Metadata

The process for developing metadata includes creating a metadata style manual and worksheet for distribution to all current and prior researchers submitting final reports to the Trustee Council. The style manual will generally follow Federal Geospatial Digital Clearinghouse content standards developed subsequent to formal adoption of metadata as authorized by Executive Order No. 12906, dated June, 1994. FGDC metadata content standards are organized with about 300 individual data elements; 199 of which consist of values, or entries describing the particular data set. Several dozen fields are considered "mandatory". An additional 100 are considered "mandatory if applicable" to the data set being described. A style manual and an encoding scheme developed by Peter Schweitzer (USGS) revised 7 February 1997 will describe syntax rules for successfully completing each metadata worksheet. The worksheet consists of a metadata utility form containing the specified 300 fields.

Preliminary metadata information will be manually extracted from each published report in the archive and entered into a separate metadata worksheet. Separate worksheets will be prepared for each significant database set reported to the Council. Each worksheet and accompanying instruction set will then be transmitted by mail or electronic means to each original principle investigator for review and completion. This will allow for

professional review of the data set, inclusion of keywords, attribute definitions and other non-published information as desired by each scientist. Distribution may be mailed as printed hardcopy, on 3.5" floppy disk, or transmitted via the internet. It is anticipated that some researchers will prefer a written format while others may wish to receive an electronic distribution. Metadata will not include actual data, but will reflect the datum, i.e. structure, content, and public availability of the database in question. Professional review allows each principle investigator to personally define all fields and attributes contained in his or her dataset; comment on changes or additions to data subsequent to the original publish date; provide for release or restrictions on scientific database information as appropriate, and update preferred contact information. As an example, archeological site information may be restricted because of concerns for renewed vandalism and loss of cultural materials. In other cases, legal or contractual restrictions may continue to restrict actual release of data. In such cases, the principle researcher may be able to specify future possible date(s) of release.

Ongoing follow-up activity will be initiated early in the project cycle to encourage respondents to complete and return all worksheet entries. In the event a respondent does not complete or return the worksheet, or is unable or unavailable to do so, the project leader will attempt to compile relevant worksheet entries from the published record. Scientific analysis, methodology, research findings or other relevant content may be quoted in context as required by the metadata content standard, but will not be interpreted editorialized for completion of the worksheet.

All returned worksheets will be verified for authenticity, validated for accuracy and georeferenced with data independently obtained from the archival record. Positional accuracy is always a concern in any geographical based information management system. Cross referencing the positional accuracy of metadata worksheet information and verifying submittals with the archival record may help reduce data entry errors or other anomalies which may dilute data relevancy. Arcview 3.1 software will be used to verify positional accuracy of submitted data. A metadata parser will be used to identify and correct file errors. File errors usually consist of missing entries in critical or mandatory fields. Particular attention will be given to examining, repairing or repopulating 'popular' fields. This process anticipates a 97% accuracy rate for all submitted metadata information. This relates to a maximum of six field anomalies for each fully completed metadata worksheet. This does not include purposely avoided fields not given a value because of context or lack of relevancy.

All written responses will be converted to digital format during completion of the project. Content will then be formatted in text, HTML, and other format as may currently be required for national Clearinghouse input as determined by the Alaska Geospatial Data Committee. Prior to input, completed metadata files will be submitted to the Trustee Council for acceptance, approval and distribution.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

All components of this project will be conducted by proposed principle investigator. No agency subcontracting is expected.

SCHEDULE

A. Measurable Project Tasks for FY 00

October 1, 1999:	Start Date
December 31:	Finalize metadata content manual, style sheets, data collection software format.
January 1-March 31:	Extract preliminary M/D info; compile, mail worksheets.
April 1-15:	Conduct user training and orientation.
April 30:	Due date respondent worksheets.
May 1-July 31:	Verify error files: follow-up delinquent worksheets.
August 15:	Compile database, text files
September 30:	Finish converting files to html, other formats
April 15, 2001	Submit final report, completed metadata content

Project Milestones and Endpoints

1) October 1, 1999:	Start date
2) October 25:	Develop metadata content manual, stylesheet
3) November 1:	Select metadata utility, configure parser
4) November 15:	Develop mailing list, send introductory letters
5) November 30:	Set up GIS database, shapefiles
6) December 31:	Finish Objective 1: Develop Metadata Format....
7) February 20:	Extract metadata from 'Final Report' archives
8) February 25:	Compile, mail work sheets
9) March 25:	Extract metadata from 'Damage Assessment Reports'
10) March 30:	Compile, mail work sheets
11) April 30:	Due date Final Report worksheets
12) May 30:	Due date, Damage Assessment Report worksheets
13) July28:	Finish Objective 2: Provide Training and Orientation....
14) August1-10:	Parser error files, verify authenticity, positional accuracy
15) August 30:	Compile, verify metadata database
16) September 30:	Finish Objective 3: Prepare Metadata for FGDC .... -Conclude html, other scripting
April 15, 2001:	Finish Objective 4: Provide ARLIS metadata.... -Submit final report, completed Metadata content

C. Completion Date

Project Completion: September 30, 2000

PUBLICATIONS AND REPORTS

Final Report Submitted: April 15, 2001

PROFESSIONAL CONFERENCES

Attendance and presentation of a metadata paper is anticipated at the Year 2000 Natural Resources GIS conference.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The cooperation and assistance of ARLIS, Chugach Regional Resources Council, Alaska Sealife Center, Kachemack Bay Ecological Characterization Project, Cordova Public Library and the Kodiak Marine Science Center will be solicited to determine interest for sponsorship and community training on Metadata content standards and application.

This metadata project is expected to be of interest to resource managers and stakeholders involved in Ecosystem Synthesis; those particularly interested in facilitating transition of key data sets from legacy to digital form; and those already involved in on-line database management, such as the Kachamak Bay Ecological Characterization Project. (Project\278).

Area wide community coordinators funded under Community Involvement (\052A) may be interested in developing metadata interpretive skills in their local communities, so as to help community members better understand the nature and content of published research.

PROPOSED PRINCIPLE INVESTIGATOR

Glenn P. Brooks
-private contractor-
18306 186th Place N. E.
Woodinville, Washington 98072
Phone: 425-844-1018
e-mail: gbrooks@nwrain.com

QUALIFICATIONS

EDUCATION:

B.A. Anthropology Major, University of Alaska, Anchorage
22 Graduate credits, Public Administration, University of Southern California
Graduate, FBI National Academy, Quantico, Virginia

TECH SKILLS:

Computer Forensics:	ArcView GIS, 1998-99. Forensic examination utilities/data recovery, 1997-1999
Applications:	MS Office Pro; Access 95/7; Financial Accounting; Schedulers; Browsers, FTP, TCP/IP, HTML; Networking essentials.
Operating Systems:	Linux; NT Workstation; Win98/95, Win 3.x, DOS.

COMPUTER EXPERIENCE:

Currently enrolled, final quarter of U/W GIS Professional Certificate Program. ArcView/GIS certified. Developed GIS spatial analysis of Alaska Pollack fishery's impact on endangered Stellar Sea Lion range in Gulf of Alaska and the Bering Sea. Currently developing two georeferenced national and state organizational membership rosters.

Researched, planned two optical character recognition legacy to digital conversion projects.

Completed computer forensic training in data recovery conducted by the International Association of Computer Investigative Specialists—1997. Received DOS seizure certificate.

Desktop/PC applications user since 1983. Four years Internet, email, on-line research experience. Seven years experience automated financial accounting systems. 16 years experience desktop editorial, authorship experience.

Currently configuring Linux/Apache/SQL web server. Planning national organization web site startup.

PROFESSIONAL DEVELOPMENT:

National Registration Chair, Seattle '99. FBI National Academy training conference volunteer coordinator, national registration activities for 3,000 delegates and vendors.

Business Executive, 1991-98. Owner/General Manager. P/L responsibility for privately held family entertainment center in Alaska. Strong experience in business analysis, marketing, fiscal accountability, coordinating distance operations, staffing. Established festival and event contracts throughout Alaska, Yukon Territories and Hawaii. Developed customer base of 35,000 patrons annually.

Policy Analyst, Consultant, 1986-1999 Event planning specialist. Developed ComFish platform; advocated habitat, industry initiatives as a commercial fisheries advisor to a statewide gubernatorial candidate. Conducted policy analysis of multimillion dollar funding mechanisms supporting Alaska Seafood Marketing Institute, Alaska Fishing Vessel Loan Programs. Researched statewide felony case files for the Alaska Judicial Council's benchmark Plea Bargaining study. Revised police academy curriculum for the University of Alaska.

Alaska Fishing Vessel Owner, 1975-1991 Ten year stakeholder, Prince William Sound Salmon fishery, PWS Aquaculture Association. USCG Licensed: Master, Near Coastal Waters, endorsed power and sail. 1300 days sea time in Alaskan waters. Developed, executed Exxon Valdez oil spill vessel contract; provided 140 days continuous vessel support for Exxon assessment and hot shot response team. Previously conducted successful marketing campaign promoting Alaska sail training, maritime tourism adventures, in the Kenai Fjords marine wilderness area. Previously conducted oceanographic research vessel charter in Prince William Sound.

Chief of Police, University of Alaska, Anchorage, 1974-1986. Planned, established, managed Police Department serving three campuses. Departmental human resources, training manager. Developed, managed accredited statewide municipal police training academy. Developed managed crime analysis program.

Alaska State Trooper, 1968-1974. Criminal investigator, patrol officer in urban and rural areas of Alaska. Field Training Officer. 100% conviction rate for all felony cases presented in court.

RESEARCH AND PUBLICATIONS:

Currently developing two georeferenced national and state organizational membership rosters.

GIS spatial analysis: Alaska Pollack fishery impact on endangered Stellar Sea Lion range in Gulf of Alaska and the Bering Sea, 1998.

Project Recommendations: City of Wasilla Winter Festival Development, Wasilla, Alaska 1994.

Grizzly Grand Prix Inc Business and Marketing Plan. A 400 page internal document describing seasonal business operations, Fairbanks, Alaska, 1991.

Fiscal Analysis of State of Alaska Commercial Fishing Vessel Loan Program, Funding Recommendations Alaska Seafood Marketing Institute, CommonSense for Alaska, 1990.

Ethics and Performance, Delinquency Control Institute, University of Southern California, 1986.

Fourth Avenue Project, spatial analysis of prostitution and drinking patterns in Anchorage's skid row district, Anchorage, Alaska, 1977

The Unixkigmiut: An archeological site survey of Eskimo habitation along the southeastern coastline of the Kenai Peninsula, Anchorage, Alaska 1976.

KEY PERSONNEL

Glenn Brooks—all phases of work

LITERATURE CITED

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$43,000.0
Travel		$2,774.0
Contractual		$2,660.0
Commodities		$450.0
Equipment		$0.0
Subtotal	$0.0	$48,884.0
Indirect		
Project Total	$0.0	$48,884.0
Full-time Equivalents (FTE)		1.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		

Dollar amounts are shown in thousands of dollars.

Comments:

FY00

Prepared:

Project Number: 00400
Project Title: Metadata
Name: Glenn Brooks

FORM 4A
Non-Trustee
SUMMARY

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2000
	Glenn Brooks	Principle Investigator	9.5	4000.0		38,000.0
	unknown	Asst Researcher/Archivist	2.0	2500.0		5,000.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	11.5	6500.0	0.0	
					Personnel Total	$43,000.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2000
	R/T: Anch-Swd-Homer-Anch	125.0	1	13	75.0	1,100.0
	R/T: Anch-Kodiak-Anch	178.0	1	5	150.0	928.0
	R/T: Anchor-Cordova-Anch	146.0	1	4	150.0	746.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$2,774.0

FY00

Project Number:
Project Title: Metadata
Name: Glenn Brooks

FORM 4B
Personnel
& Travel
DETAIL

Prepared:

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
1 Internet Acess Services 12 mo @$40/mo	480.0
2 Printing (600 forms, 1500 Letters, envelopes, 500 Brochures, estimated)	1,600.0
3 Postage	580.0
4 Long Distance Phone Charges	
Contractual Total	$2,660.0

Commodities Costs:	Proposed
Description	FY 2000
1 Metadata Utility, Parser software	250.0
2 Media, 3.5" disk, CDROM, covers, etc	100.0
3 Paper, archival supplies, etc	100.0
Commodities Total	$450.0

FY00

Prepared:

Project Number:
Project Title: Metadata
Name: Glenn Brooks

FORM 4B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2000
Description			
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number of Units	
Description		

FY00

Project Number:
Project Title:
Name:

FORM 4B
Equipment
DETAIL

Prepared:

ASSESSMENT OF SPOT SHRIMP ABUNDANCE IN PRINCE WILLIAM SOUND A DECADE AFTER THE EXXON VALDEZ OIL SPILL

Project Number:	00401
Restoration Category:	General Restoration
Proposer:	Charles E. O'Clair and Mandy Lindeberg NMFS, Auke Bay Laboratory ABL Project Manager: Dr. Stan Rice NOAA Project Manager: Bruce Wright
Lead Trustee Agency:	NOAA
Cooperating Agencies:	Valdez Native Tribe/Charlie Hughey Prince William Sound Economic Development Council
Alaska Sea Life Center:	No
Duration:	2nd year, 4 year project
Cost FY 00:	$90,800
Cost FY 01:	$95,000
Cost FY 02:	$33,000
Geographic Area:	Prince William Sound
Injured Resource/Service:	Spot Shrimp/Subsistence

ABSTRACT

This proposal is for year two of a four year project. The project will estimate the abundance of spot shrimp and determine the structure of the spot shrimp population in 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 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/pot (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/pot to 0.2 kg/pot. 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). This proposal covers year two of the four year study. The study will augment the ADF&G sampling program by adding population information from other areas in PWS, will enhance our understanding of spot shrimp population dynamics by providing information on juvenile distribution, abundance, and size structure, and will ultimately aid ADF&G in developing a management plan for spot shrimp when the population recovers. In FY=99 NMFS personnel took input from the Valdez Native Tribe and former PWS commercial shrimpers to identify potential sampling sites. A preliminary, exploratory cruise will be conducted in August 1999 to evaluate potential 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. Rational/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 goal of this study 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 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

This study focuses on various sites in the Traditional Harvest Area for spot shrimp in western Prince William Sound, but will include sites in other parts of the Sound as well. The project will include sites currently surveyed by ADF&G as well as additional sites in statistical reporting areas currently surveyed and in other 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. 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 or circular, stacking pots will be used. Rectangular pots measuring 41 cm x 41 cm x 91 cm (16 in x16 in x 36 in) are used by the ADF&G. The pots are covered with black woven plastic fabric (engineers cloth) except in the two opposing tunnel ends which have a 6.4 cm (2.5 in) tunnel opening set 18 cm (7 in) into each end of the pot. The tunnels are enclosed by 1.3 cm (0.5 in) stretched mesh web. A single 2.4 L perforated plastic jar containing chopped herring is placed in each pot at the time of deployment. If circular pots are ultimately used in this study, the circular pots will be fished along with the ADF&G rectangular design in a side by side comparison to test the relative efficiency of the two pot designs. 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 August 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 FY00 (October 1, 1999-September 30, 2000)

October 1 - 31	Sample spot shrimp at ADF&G sampling sites as well as six additional sites.
November 1 - March 31	Process egg samples and analyse data on spot shrimp abundance, sex and size composition, and relative number of egg-bearing females and fecundity of spot shrimp at the study sites in year one.
April 1 - September 30	Respond to reviewers comments on annual report and arrange logistics for sampling cruise in October 2000.

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 fecundity of 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

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

Travel funds are requested for attendance of two individuals at the annual Exxon Valdez Restoration Workshop in January 2000.

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.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

No sampling has been conducted in conjunction with this project yet. Exploratory fishing will take place in August 1999. When sampling is begun circular pots may have to be substituted for the rectangular pots that ADF&G uses. If circular pots are used they will be cross-calibrated with the rectangular pots before full sampling is begun.

PROPOSED PRINCIPAL INVESTIGATORS

Charles E O=Clair
National Marine Fisheries Service
Auke Bay Laboratory
11305 Glacier Highway
Juneau, AK 99801-8626
Tele: (907) 789-6016, FAX: (907) 789-6094
email: chuck.o=clair@noaa.gov

Mandy Lindeberg
National Marine Fisheries Service
Auke Bay Laboratory
11305 Glacier Highway
Juneau, AK 99801-8626
Tele: (907) 789-6616
email: mandy.lindeberg@noaa.gov

Charles Hughey, Valdez Native Tribe
P. O. Box 1108
Valdez, AK 99686
Tele: (907) 835-4951
FAX: (907) 835-5589

Sue Cogswell, Executive Director
Prince William Sound EDC
P. O. Box 2353
Valdez, AK 99686
Tele: (907) 835-3775, FAX (907) 835-5770
E-mail pwsedc@alaska.net

PRINCIPAL INVESTIGATORS

Charles G. Hughey is a commercial fisherman, EVOS community facilitator for Valdez, and

serves on the Alaska Fish and Game Advisory Committee.

Sue Cogswell is executive director of Prince William Sound Economic Development Council and has experience in project management.

Charles E. O=Clair will be responsible for sampling, data analysis and interpretation and report writing. For qualifications see curriculum vitae below.

Mandy Lindeberg. will be responsible for arranging logistics (vessels, equipment, contracts, etc.), will participate in sampling, data processing, and will assist in report writing. For qualifications see curriculum vitae below.

Curriculum Vitae

CHARLES E. O'CLAIR

PRESENT POSITION

1977-Present Fishery Biologist, Research, Habitat Investigations, Auke Bay Laboratory, National Marine Fisheries Service, National Oceanic and Atmospheric Administration.

Research experience includes 15 years of research on the ecology and behavior of Dungeness, king, and tanner crabs in relation to crab movements and the effects of log transfer facilities, low temperature aerial exposure and fishery impacts on crab populations, 1981-present. Principal Investigator or Co-Principal Investigator on nine studies in conjunction with this research.

Experience also includes 11 years of field and laboratory sampling and experimentation on the effects of oil pollution on benthic invertebrates in conjunction with the Outer Continental Shelf Environmental Assessment Program and the *Exxon Valdez* oil spill. Principal Investigator or Co-Principal Investigator on six studies associated with the *Exxon Valdez* spill.

PREVIOUS POSITIONS

1983-1987 Affiliate Assistant Professor of Fisheries, School of Fisheries and Science, University of Alaska, Juneau.

1968-1974 Research assistant, Fisheries Research Institute, University of Washington, Seattle. Six years of experience studying intertidal and subtidal community ecology at Amchitka Island, Alaska and the response of intertidal communities there to land level change caused by underground nuclear tests. These studies were part of the Amchitka Bioenvironmental Program of Battelle Memorial Institute, Columbus, Ohio.

Education

Ph.D. 1977 University of Washington, Fisheries
B.S. 1963 University of Massachusetts, Zoology

SCIENTIFIC ORGANIZATION MEMBERSHIPS

Ecological Society of America
Sigma Xi
The Crustacean Society
Western Society of Naturalists

HONORS

National Oceanic and Atmospheric Administration Certificate of Recognition "For outstanding contributions as a NOAA employee serving the public trust in response to the EXXON Valdez Oil Spill disaster in April 1989".

National Oceanic and Atmospheric Administration Certificate of Recognition for a "high level of performance for the period (04-01-89 - 03-31-90)".

PROFESSIONAL PUBLICATIONS

O'Clair, C. E. and K. K. Chew. 1971. Transect studies of littoral macrofauna, Amchitka, Alaska. Bioscience 21:661-664.

O'Clair, C. E. 1977. Marine invertebrates in rocky intertidal communities. In: The environment of Amchitka Island, Alaska. M. L. Merritt and R. G Fuller, Eds. National Technical Information Service, Energy Research and Development Administration, Springfield, VA pp. 395-449.

O'Clair, C. E. 1981. Disturbance and diversity in a boreal marine community: the role of intertidal scouring by sea ice. In The Eastern Bering Sea Shelf: Oceanography and Resources, Vol. 2. D. W. Hood and J. A. Calder, Eds. University of Washington Press, Seattle. pp. 1105-1130.

O'Clair, C. E. and S. D. Rice. 1985. Depression of feeding and growth rates of the seastar *Evasterias troschelii* during long-term exposure to the water-soluble fraction of crude oil. Mar. Biol. 84:331-340.

O'Clair, C. E. and S. T. Zimmerman. 1987. Biogeography and ecology of intertidal and shallow subtidal communities. In: The Gulf of Alaska: Physical Environment and Biological Resources. D. W. Hood and S. T. Zimmerman, Eds. National Technical Information Service, Springfield, Virginia. pp. 305-344.

Freese, J. L. and C. E. O'Clair. 1987. Reduced survival and condition of the bivalves *Protothaca staminea* and *Mytilus edulis* buried by decomposing bark. Marine Environ. Res. 23:49-64.

O'Clair, C. E. and J. L. Freese. 1988. Reproductive condition of Dungeness crabs, *Cancer magister*, at or near Log Transfer Facilities in Southeastern Alaska. Marine Environ. Res. 26:57-81.

Morado, J. F., A. K. Sparks and C. E. O'Clair. 1988. A preliminary study of idiopathic lesions in the Dungeness crab, *Cancer magister*, from Rowan Bay, Alaska. Marine Environ. Res. 26:311-318.

O'Clair, C. E., R. P. Stone and J. L. Freese. 1990. Movements and habitat use of Dungeness crabs and the Glacier Bay Fishery. In: Milner, A. M. and J. D. Wood. Proceedings of the Second Glacier Bay Science Symposium: September 19-22, 1988. Gustavus, Alaska. U.S. Department of the Interior, National Park Service, Alaska Regional Office, Anchorage, Alaska. pp. 74-77.

Carls, M. G., and C. E. O'Clair. 1990. Influence of cold air exposures on ovigerous Red King crabs (*Paralithodes camtschatica*) and Tanner crabs (*Chionoecetes bairdi*) and their offspring. In: Proceedings of the International Symposium on King and Tanner Crabs. November 28-30, 1989. Anchorage, Alaska. University of Alaska, Alaska Sea Grant College Program Report No. 90-94. pp. 329-343.

Stone, R. P., C. E. O'Clair and T. C. Shirley. 1992. Seasonal migration and distribution of female red king crabs in a southeast Alaskan estuary. J. Crust. Biol. 12(4):546-560.

Stone, Robert P., C. E. O'Clair and T. C. Shirley. 1993. Aggregating behavior of ovigerous female red king crabs, *Paralithodes camtschaticus*, in Auke Bay, Alaska. Can. J. Fisheries Aquat. Sci. 50(4):750-758.

Wolfe, D. A., M. J. Hameedi, J. A. Galt, G. Watabayashi, J. Short, C. O'Claire, S. Rice, J. Michel, J. R. Payne, J. Braddock, S. Hanna and D. Sale. 1994. The fate of the oil spilled from the *Exxon Valdez*. Environ. Sci. Technol. 28(13):561A-568A.

Carls, M. G., and C. E. O'Clair. 1995. Responses of Tanner Crabs, *Chionoecetes bairdi*, exposed to cold air. Fish. Bull. 93:44-56.

Leder, E. H., T. C. Shirley and C. E. O'Clair. 1995. Male size and female reproduction in Dungeness crab in

Glacier Bay, Alaska. *In* D.R. Engstrom ed., Proceedings of the Third Glacier Bay Science Symposium. U.S. Department of the Interior, National Park Service, Alaska Regional Office, Anchorage, Alaska. p 203-208.

O'Clair, C. E., J. L. Freese, R. P. Stone, T. C. Shirley, E. H. Leder, S. J. Taggart and G. H. Kruse. 1995. Nearshore distribution and abundance of Dungeness crabs in Glacier Bay National Park, Alaska. *In* D.R. Engstrom ed., Proceedings of the Third Glacier Bay Science Symposium. U.S. Department of the Interior, National Park Service, Alaska Regional Office, Anchorage, Alaska. p 196-202.

O'Clair, C. E., J. W. Short and S. D. Rice. 1996. Contamination of intertidal and subtidal sediments by oil from the *Exxon Valdez* in Prince William Sound. Pages 61-93 *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 Symposium 18, Bethesda, Maryland.

O'Clair, C. E., T. C. Shirley and S. J. Taggart. 1996. Dispersion of adult *Cancer magister* at Glacier Bay, Alaska: variation with spatial scale, sex and reproductive status. Pages 209-227 *In* High Latitude Crabs: Biology, Management, and Economics. Alaska Sea Grant College Program Report No. 96-02, University of Alaska Fairbanks.

Schultz D. A., T. C. Shirley, C. E. O'Clair, and S. J. Taggart. 1996. Activity and feeding of ovigerous Dungeness crabs in Glacier Bay, Alaska. Pages 411-424 *In* High Latitude Crabs: Biology, Management, and Economics. Alaska Sea Grant College Program Report No. 96-02, University of Alaska Fairbanks.

Shirley, T. C., C. E. O'Clair, S. J. Taggart and J. Bodkin. 1996. Sea otter predation on Dungeness crabs in Glacier Bay, Alaska. Pages 563-576 *In* High Latitude Crabs: Biology, Management, and Economics. Alaska Sea Grant College Program Report No. 96-02, University of Alaska Fairbanks.

PAPERS PRESENTED AT REGIONAL AND NATIONAL MEETINGS

O'Clair, C. E. and E. I. Fritts. 1980. Predation and the maintenance of free space on a rocky shore in southeastern Alaska. Presented at the joint annual meeting of eight national biological organizations including the Ecological Society of America and the American Society of Limnology & Oceanography; coordinated by the American Society of Zoologists, 27-30 December 1980, Seattle, Washington.

O'Clair, C. E. and L. Freese. 1983. Somatic and reproductive abnormalities in the crab *Cancer magister* at a log transfer facility in southeastern Alaska. Presented at the 64th Annual Meeting of the Western Society of Naturalists, 27-30 December 1983, Simon Fraser University, Burnaby, British Columbia.

Freese, L. and C. E. O'Clair. 1984. Condition of Dungeness crabs, *Cancer magister,* at a benthic deposit of decomposing bark: physical trauma and reduced reproductive success. Presented by L. Freese at the Symposium on Dungeness Crab Biology and Management, 9-11 October 1984, Anchorage, Alaska.

O'Clair, C. E. and L. Freese. 1984. Responses of Dungeness crabs, *Cancer magister,* exposed to bark debris from benthic deposits at log transfer facilities: survival, feeding and reproduction. Presented at the Symposium on Dungeness Crab Biology and Management, 9-11 October 1984, Anchorage, Alaska.

O'Clair, C. E. 1988. Fine-scale movements of *Cancer magister* in southeastern Alaska. Presented at the joint 1988 meeting of seven biological organizations including the Crustacean Society and coordinated by the American Society of Zoologists, 27-30 December 1988, San Francisco, California.

Stone, R. P. and C. E. O'Clair. 1989. Seasonal migration of primiparous and multiparous female red king crabs (*Paralithodes camtschatica*). Presented by R. P. Stone at the International Symposium on King and Tanner Crabs. November 28-30, 1989.

O'Clair, C. E., J. W. Short and S. Rice. 1993. Contamination of subtidal sediments by oil from the *Exxon Valdez* in Prince William Sound, Alaska. Presented at the *Exxon Valdez* Oil Spill Symposium, February 2-5, 1993, Anchorage, Alaska.

Rice, S., B. A. Wright, J. W. Short and C. E. O'Clair. 1993. Subtidal oil contamination and biological impacts. Presented by S. Rice at the *Exxon Valdez* Oil Spill Symposium, February 2-5, 1993, Anchorage, Alaska.

Shirley, T. C., J. W. Fleeger, C. E. O'Clair and S. Rice. 1993. Responses of intertidal and subtidal meiofauna to the Prince William Sound oil spill. Poster at the *Exxon Valdez* Oil Spill Symposium, February 2-5, 1993, Anchorage, Alaska.

Shirley, T. C., D. A. Woodby, Shijie Zhou and C. E. O'Clair. 1993. Population estimation of red king crabs in a fjord in southeast Alaska: a comparison of methods. Presented by T. C. Shirley at the 123rd Annual Meeting of the American Fisheries Society, August 29 - September 3, 1993, Portland, Oregon.

O'Clair, C. E., T. C. Shirley and S. J. Taggart. 1995. Dispersion of adult *Cancer magister* at Glacier Bay, Alaska: variation with spatial scale, sex and reproductive status. Presented at the International Symposium on Biology, Management, and Economics of Crabs from High Latitude Habitats. October 11-13, 1995, Anchorage, Alaska.

MANDY R. LINDEBERG

Research experience includes 9 years of field work in Prince William Sound after the EVOS. This consisted of managing field and laboratory processing of samples along with preparing data into statistical and graphical summaries for annual reports, presentations, and posters for the EVOS Trustee Council.

Relevant Experience:

present - 1996 Fisheries Research Biologist, NOAA/NMFS, Auke Bay Laboratory, Juneau, Alaska. Three years of work on the mussel component of the EVOS Nearshore Vertebrate Predator project. The mussel component is looking at the availability of mussels to sea otters and sea ducks in oiled verses non-oiled areas. In 1998 I provided algal expertise to the NOAA Hazmat monitoring study in Prince William Sound.

1990 - 1996 Laboratory Technician II, UAF, Juneau Center for School of Fisheries and Ocean Sciences, Juneau, Alaska. Six years of work on the EVOS Coastal Habitat project, specifically those aspects which dealt with the damage assessment, restoration, and long term monitoring of intertidal algae. In addition to these research skills, I have a specialized knowledge of intertidal algal taxonomy in Prince William Sound and Kachemak Bay. During 1996 I was contracted to make a complete voucher collection of intertidal algal species for Kachemak Bay through CMI.

Education: BS 1989, Marine Biology, Western Washington Univ., Bellingham,Washington.

Reports/Publications:

Mandy R. Lindeberg, Charles E. O=Clair and Susan M. Saupe. EVOS Restoration Project 98025 Poster ALong-Term Population Trends of Mussels in Herring Bay@

Charles E. O=Clair and Mandy R. Lindeberg. EVOS Restoration Project 97025 Poster AAre Mussels Limiting as Prey for Sea Otters in Oiled Areas?@

Charles E. O=Clair and Mandy R. Lindeberg. EVOS Restoration Project 96025 Annual Report AMussel Component: Mussel Populations in Relation to the Recovery of Nearshore Vertebrate Predators in Areas Oiled during the *Exxon Valdez* spill.@

Charles E. O=Clair and Mandy R. Lindeberg. EVOS Restoration Project 96025 Poster A Are Mussels as Prey Limiting the Recovery of Sea Otters in Oiled Areas of Prince William Sound.@

Stekoll, M. S., L. Deysher, R. C. Highsmith, S. M. Saupe, Z. Guo, W. P. Erickson, L. McDonald,

and D. Strickland. 1996. Coastal habitat injury assessment: Intertidal communities and the *Exxon Valdez* oil spill. Pages 177-192 *In:* Rice, S.D., R.B.Spies, D. A. Wolfe, and B. A. Wright, eds. Proceedings of the *Exxon Valdez* Oil Spill Symposium. American Fisheries Society Symposium 18.

Highsmith, Raymond C., Rucker, T.L., Stekoll, M.S., Saupe, S.M., Lindeberg, M.R., Jenne, R.N., Erickson, W.P. 1996. Impact of the *Exxon Valdez* Oil Spill on Intertidal Biota. American Fisheries Society Symposium 18:212-237.

OTHER KEY PERSONNEL

None

LITERATURE CITED

Orensanz, J. M., J. Armstrong, D. Armstrong and R. Hilborn. 1998. Crustacean resources are vulnerable to serial depletion - the multifaceted decline of crab and shrimp fisheries in the Greater Gulf of Alaska. Reviews in Fish Biology and Fisheries 8: 117-176.

Trowbridge, C. 1992. Injury to Prince William Sound spot shrimp. Final report for Exxon Valdez Oil Spill State/Federal Natural Resource Damage Assessment Subtidal Study Number 5. 141 p.

Trowbridge, C. 1994. Spot shrimp *Pandalus platyceros* surveys in the Prince William Sound management area, 1989 -1993. Regional Information Report No. 2A94-31. Alaska Department of Fish and Game. Anchorage, Alaska. 30 p.

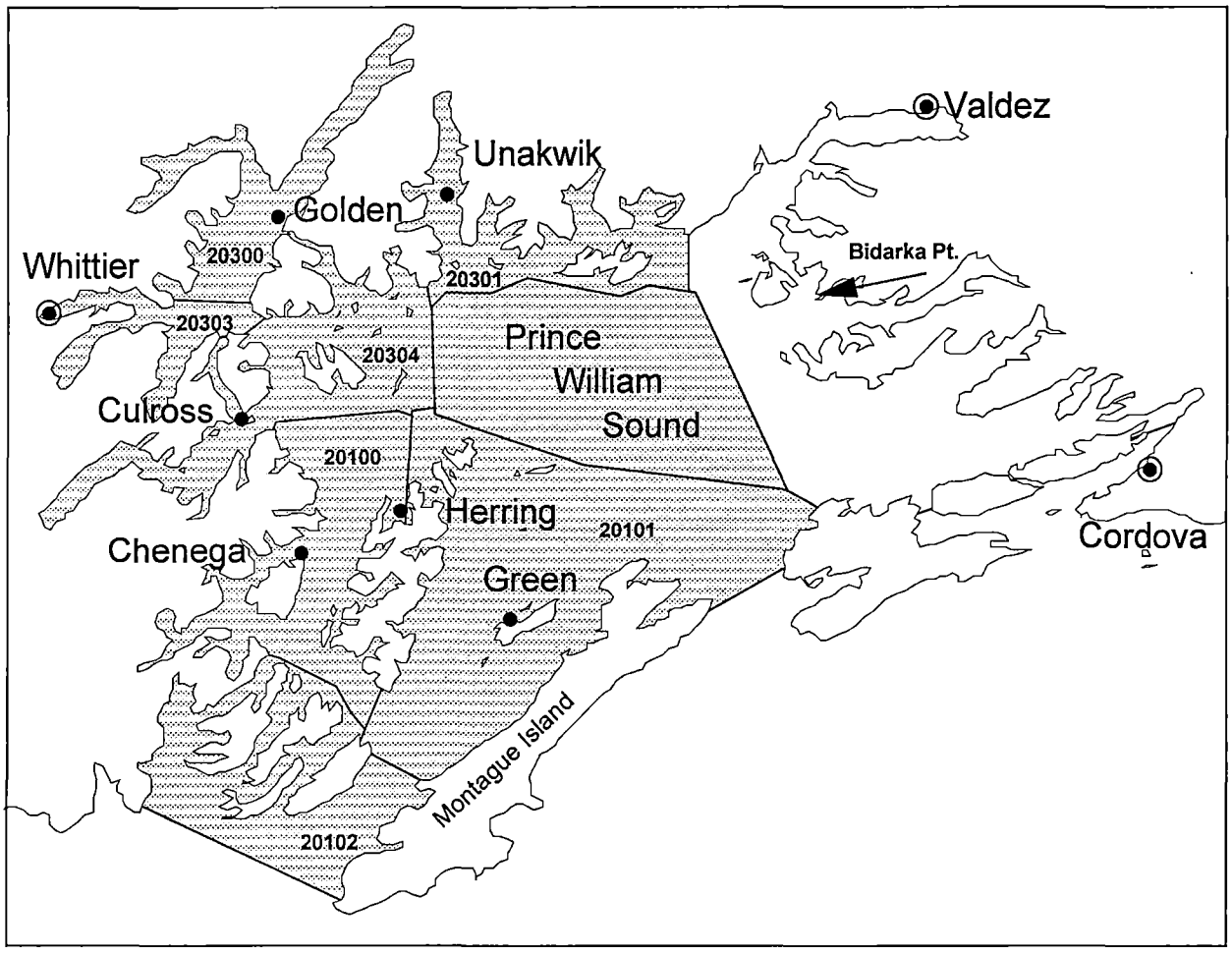


Figure 1. Proposed sampling area (shaded) and core sampling sites (closed circles) for spot shrimp abundance and population structure in western Prince William Sound. Alaska Department of Fish and Game major statistical areas for reporting commercial shellfish catch are outlined within the shaded area. (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)

2000 EXXON VALDEZ TRI COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel	$12.0	$40.7
Travel	$6.6	$4.4
Contractual	$15.0	$34.5
Commodities	$1.8	$2.7
Equipment		$0.0
Subtotal	$35.4	$82.3
General Administration	$2.9	$8.5
Project Total	$38.3	$90.8
Full-time Equivalents (FTE)	0.2	0.6
Other Resources		$16.9

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 2001	Estimated FY 2002
$95.0	$33.0

Dollar amounts are shown in thousands of dollars.

Comments:

Prince William Sound Economic Council will administer the contract with the Valdez Native Tribe who will supply the survey vessel including fuel, Captain, deck hand, gear, and food.

NOAA Contribution: CE O'Clair, P-I 1 mo @8.6K, Dr. Stan Rice, Program Manger, .5 mo@6K, M. Lindeberg .5 mo @ 2.3K for a total NOAA contribution of 16.9K

FY00

Prepared:4/12/99

Project Number: 00401
Project Title: Spot Shrimp - A Population Dynamics Study
Agency: National Oceanic and Atmospheric Administration

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
O'Clair, C. E.	Fishery Research Biologist	GS-12/10	2.0	8.6		17.2
Lindeberg, M.	Fishery Research Biologist	GS-9/3	5.0	4.7		23.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		7.0	13.3	0.0	
					Personnel Total	$40.7

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
JNU/VDZ/JNU	0.6	2	4	0.2	2.0
JNU/ANC/JNU	0.4	2	8	0.2	2.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.4

FY00

Prepared:4/12/99

Project Number: 00401
Project Title: Spot Shrimp - A Population Dynamics Study
Agency: National Oceanic and Atmospheric Administration

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRI COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
Vessel Charter	24.5
Fecundity and egg mortality analysis	10.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$34.5

Commodities Costs:	Proposed
Description	FY 2000
Portable Balance	0.7
Measuring, weighing and laboratorysupplies.	2.0
Commodities Total	$2.7

FY00

Prepared:4/12/99

Project Number: 00401
Project Title: Spot Shrimp - A Population Dynamics Study
Agency: National Oceanic and Atmospheric Administration

FORM 3B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRI COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2000
			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		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

FY00

Project Number: 00401
Project Title: Spot Shrimp - A Population Dynamics Study
Agency: National Oceanic and Atmospheric Administration

FORM 3B Equipment DETAIL

Prepared:4/12/99