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Effect of Viral Hemorrhagic Septicemia Virus on Overwinter Survival of Juvenile Herring in Resurrection Bay, Alaska: Implications for Year-Class Strength

Project number:	00562
Restoration Category:	Research
Lead Agency:	Alaska Department of Fish and Game
Proposer:	University of Washington & USGS-BRD
Cooperating Agencies:	USGS-BRD, Seattle, WA
Duration:	FY '00 -> FY 02
Cost for 1st year:	FY 00: $82.1K
Cost of FY 01-02:	$ 102.0 and 105.9 K
Geographic area:	Resurrection Bay, Seward, AK
Injured resource:	Herring

ABSTRACT

Viral Hemorrhagic Septicemia Virus (VHSV) has been identified in age-0 Pacific herring soon after metamorphosis (~ 3 months), and has been shown to be highly pathogenic, causing mortality in excess of 50% in captive fish. We have also shown that herring that survive initial exposure develop a solid immunity to reinfection, even when challenged with high concentrations of virus.

Our hypothesis is that in most years some portion of each age-0 herring cohort is infected and recovers from VHS, and that they are capable of surviving subsequent exposures to the virus as they age. Less frequently, an age-0 school or entire cohort avoids exposure to the virus and proceeds into their second and third year with no protective immunity, resulting in massive losses when they are ultimately exposed to older VHS-infected fish. On the contrary, we have also observed situations where virtually an entire cohort is exposed to sublethal levels of virus during their first year and all are resistant to subsequent reinfection. If either of these two extremes, (eg no immune fish vs most immune fish) are superimposed on a population that has good (or poor) overwintering fat reserves, the possibility of VHS influencing the strength of a year class becomes evident.

To test our hypothesis, we propose to capture age-0 herring in Resurrection Bay, AK from July through September 2000 and again in April 2001 and evaluate their condition (K factor) as well as susceptibility (immunity) to VHS. This will be done by capturing fish from "bait balls", transporting them to the laboratory and observing them for 30 days. Baseline samples of tissue and blood will be taken immediately after capture, as well as length and weight for condition factor determination. The change in susceptibility to VHSV over time as well as development of protective antibodies will be correlated with changes in condition factor over the same period. Samples taken from the same stocks in April will give us data on how much the condition factor changed over winter, as well as what proportion of the fish developed an immunity before entering their second year.

If our hypothesis proves to be correct, then sampling of late summer or early spring age-0 and age-1 herring should produce data that are critical in developing a model that predicts the combined effects of disease and condition on survival of juvenile herring. This operation would have minimal costs and require relatively few man-hours, but would add a significant component to any predictive survival model..

INTRODUCTION

This project is a logical extension of work conducted between 1995 and 1998, and is designed to determine whether VHS virus in 0-year herring can affect age-class strength. Previous studies (95320S, 96162, 97162, 98162) showed that VHSV is capable of causing high levels of morbidity and mortality in herring by 4-6 months post-hatch. VHSV has been shown to be transmitted via water at concentrations < 100 $pfu*ml^{-1}$ (Kocan et al. 1997). In Prince William Sound the prevalence rate of VHSV in spawning herring has fluctuated annually and seasonally since 1994, when surveys first began (Marty et al 1995, 1996, 1997). In 1997 an unexpected significant increase in the level of VHSV infection appeared for the first time in several years and continued into 1998. Recent data shows that this increase is associated with mortality in younger age-classes of the spawning population (Marty 1999).

Because of the highly vulnerable nature of juvenile herring (and other forage fish), this project is designed to determine whether early exposure to VHS virus influences subsequent susceptibility and survival of fish recruiting into the spawning population.

Age-0 fish will be captured from different areas throughout Resurrection Bay, AK from July through September, 2000 and again in April, 2001, then examined for VHSV prevalence, resistance and antibody titer. Use of the Alaska SeaLife Center is proposed as a base of operations and a holding facility for herring used in these studies. A site-visit by the PI to the ASL Center in March 1999 confirmed that the facilities were adequate for this study and that little or no down-time would be involved in designing collecting or holding facilities. Collaboration with the USGS NW Biological Science Center (Seattle) for virus assays and antibody work has also been arranged (see attached letter of agreement).

NEED FOR THE PROJECT

A. Statement of Problem

Pacific herring *(Clupea pallasi)* are an injured biological resource in Prince William Sound classified as "not recovering" as of January 1998. Because of population crashes in 1993 and 1994, commercial herring fishing was closed through 1996, resulting in economic losses and lost services. Following the population declines in herring, significant declines in marine birds and mammals which depend on herring as a forage food have been reported. Thus, the reduction in herring numbers in PWS has the potential for significant impacts throughout the ecosystem. Pacific herring are a major resource in Prince William Sound from both the commercial and ecological perspectives. In addition, herring and herring spawn are harvested annually for subsistence purposes and form an important part of the local native culture of Chenega and Tatitlek. Herring fisheries in PWS in the past have had an average annual combined ex-vessel

value of $8.3 M. In 1993, the ex-vessel value dropped to $2.0 M due to low abundance and the prevalence of small fish with low market value.

In 1993, over half of the ~130,000 tons of spawning Pacific herring expected to return to PWS failed to appear. Among those that did return, 15-42% behaved abnormally and had hemorrhagic ulcers on their skin. Pathologists from ADF&G isolated VHSV from some PWS herring and from skin lesions of a Pacific cod (*Gadus macrocephalus*) caught nearby. At the same time, herring with similar skin lesions were found near Kodiak Island, although the fishery there met predicted expectations. In 1994 only 20,000 tons of herring returned to PWS and little or no spawning occurred. In 1994, 20% of spawning fish had moderate to severe external lesions. VHSV was isolated from 11/233 (5.7%) and has been suggested as a possible cause of the 1993 population crash. Samples have been taken annually in PWS as well as Sitka Sound to determine the role of VHSV in the etiology of the 1993 - 94 epizootics. Studies in our laboratory have demonstrated that the VHS virus is carried by relatively few fish at any one time, and that transmission to nonimmune individuals occurs when conditions are right - such as during spawning events and when fish are confined in net pens.

As with any other disease, survival of an infection by VHSV depends on the state of health of the individual when exposed to the pathogen. Undernourished individuals will not have the same survival potential as well nourished individuals. Consequently, nonimmune fish with low overwinter fat reserves are more likely to die of VHS if subsequently exposed to virus when they join other schools during their second year, while those that are immune would be less likely to succumb because only their fat reserves need to be restored each spring. Conversely, nonimmune fish with high fat reserves would also would also be affected by being pushed to a lower survival level when exposed to the virus in the spring.

In summary, a combination of health effects may be responsible for survival of juvenile herring. Overwinter fat reserves in conjunction with their immunity to VHSV will significantly affect herring survival from age-0 through age-3, when they first enter the spawning population. Cohorts of nonimmune age-3 herring which enter a spawning population of infected older fish would be highly vulnerable to VHS.

B. Rationale - Link to Restoration

In order for herring to recover to historic levels, there must be several strong recruitment years in addition to long-term survival of the spawning population. When juvenile herring are lost to diseases, future year-classes become depressed. Because 0-year and 1+ herring are not studied and sampled as vigorously as adults, losses may be inapparent, and because these fish are constantly being stalked by predators, little evidence of mass mortalities would be seen. When once plentiful baitfish can no longer be found in their normal areas, it is not uncommon for local fishermen to state that "... the baitfish have moved out of the area", which may translate into: "The herring have died, but we can't prove it!".

During FY 97-98 studies (Herring Disease; 97162-98162), we were able to demonstrate that juvenile herring are extremely susceptible to mortality caused by exposure to VHSV and that the same type of epizootics observed under laboratory conditions also occur in wild free-ranging fish Kocan et al 1999). Whole populations of free-ranging herring and sandlance were found to be

resistant to challenge infection by VHSV just 30 days after they experienced a massive epizootic. If free-ranging herring develop immunity similar to that observed under laboratory conditions, then it is more probable than not that resistant wild fish were exposed to the virus, recovered and developed an immunity to VHSV, just as they do in the laboratory. What proportion of wild juvenile herring survive exposure to VHSV is presently unknown, and is the object of this proposal.

Three major environmental factors are involved in our hypothesis of juvenile herring survival. The first is that proposed by Cooney et al (1999) that herring overwinter survival is dependent on the amount of body fat (reserves) they have at the end of the previous summer. The second factor is that VHS prevalence is highest in the spring (Marty 1999), and third, our hypothesis; that the condition of the overwintering herring superimposed on their immune status determines their survival potential when exposed to VHSV each spring.

Summary of Major Hypotheses

- Juvenile herring and/or sandlance are exposed to VHSV at low levels early in life and survivors develop a lasting acquired immunity to reinfection.
- Juvenile herring/sandlance rearing in different geographic locations can have different disease histories and different survival rates depending on local conditions.
- Survival of juvenile herring depends upon multiple superimposed factors such as disease resistance (immunity), overwinter condition and probability of exposure to VHS virus in the spring.
- Disease-related mortality in juvenile herring and sandlance can significantly impact future abundance and recruitment.

Integrated hypotheses: Because disease causes direct and indirect losses of juvenile herring, it could be a major factor in determining the recruitment strength at 3 - 4 years post-hatch. Juvenile herring and sandlance are most vulnerable to pathogens, suffering greater morbidity and mortality than mature fish. When juveniles become infected they can die outright, or are weakened and at a competitive disadvantage to their healthy cohorts. Diseased fish are more likely to starve when food supplies are low and more likely to be targeted by predators due to their erratic behavior and inability to escape, while immune fish in good nutritional condition are more likely to survive exposure to pathogens.

C. Location

Field collections will be made in Resurrection Bay, Alaska with operations based at the Alaska Sea Life Center (Seward). The ASLC has the necessary facilities for short-term holding of herring for disease and natural immunity studies. Blood and tissue samples collected from experimental fish will initially be processed at the ASLC, then transported to other laboratories within Alaska or Washington where the necessary technology for processing the samples is available - such as plaque assays or PCR analysis. Discussions with the director and staff of ASLC have indicated that the project would be appropriate for the Center and that the majority of the facilities are available for studying juvenile herring throughout the year.

Facilities anticipated at the ASLC for 3-5 months would include: 1 office; 4 -6 flow-through seawater water tanks @ 100 to 200 g each; low temperature incubator; lab space and hood for cell culture; O_2 tanks for fish transfer; necropsy facility; 0.5 months on-site technical help.

COMMUNITY INVOLVEMENT

An annual progress report will be presented at a Restoration Science Workshop, scheduled to be held in Anchorage each January. Principal investigators will be available on request to speak with the media and public while actively working at the ASLC and by phone during the remainder of the year. If requested, seminars and / or demonstrations will be arranged for community members at any time of the year - including at the time of the annual Workshop held in January. Activities at the ASLC would also be presented to the public as displays or seminars to groups when research staff are available on-site.

PROJECT DESIGN

A. Objectives

Objectives (FY 00 - 02):

- Determine changes in VHS-induced mortality rate in age-0 herring collected from June through September and April for two consecutive years (sandlance will also be utilized if available).

- Monitor the immune status of wild juvenile herring (and sandlance) during their first two years post-hatch to determine the rate at which they develop resistance to reinfection.

- Monitor changes in serum antibodies to VHSV for age-0 and 1+ herring by obtaining serum from fish at the time of collection (2 samples / month from June --> September & April)

- Determine condition factor for age-0 fish from June --> September and again in April.

- Correlate overall survival of 1+ herring with overwinter condition factor and resistance to VHS in the spring.

B. Methods

1) General Methodology & Facilities (FY 00, 01, 02)

o Fish collections

Using techniques developed during previous EVOS projects (95320S, 96162, 97162, 98162), age-0 herring and sandlance will be collected using a cast net from "bait balls" in Resurrection Bay and transported to holding tanks at the Sea Life Center where they will be evaluated for 30 - 60 days. Approximately 500 -1,000 age-0 fish will be evaluated for each collection time. VHS prevalence and condition factor at the time of capture (t_0)will be determined by assaying 100 random fish from each collection.

o VHSV in captive wild herring

During their time in captivity (t_1 -> t_{30}) subsamples of 60 fish will be taken at regular intervals and the progression of the virus determined by plaque assay of tissues and holding water. Relative survival and development of immunity will be recorded from June through September to determine the rate at which the population becomes more resistant as it ages and again in April to determine the condition of the population after overwintering.

These data will then be used to evaluate the groups ability to survive a VHS epizootic. Exposures will be natural, initiated by holding approximately 1,000 fish in 200 g flow-through seawater tanks for 30 days. If our hypothesis is correct, populations with similar condition factors should have similar survival rates when exposed to VHSV. Those with the lowest condition factors should suffer the greatest mortality, while those with the highest factors should have the highest survival rates. There should also be a progressive increase in resistance (immunity) as the population ages.

By using data collected during the summer months, a prediction of age 1+ resistance to VHSV should be possible. This will be tested by collecting age 1+ fish from Resurrection Bay in April and evaluating their condition after overwintering and then exposing them to VHSV in holding tanks to determine their survival potential.

Once mortality has ceased, fish from each collection period will be challenged with a known lethal dose of VHS virus (usually after 30 days in captivity) to demonstrate their resistance to reinfection. This will be done by lowering the water in the holding tanks to about 6 inches, then adding enough virus to produce a final concentration of 1-5 X 10^3 $pfu*ml^{-1}$. Individuals that survived earlier epizootics (wild or captive) will be resistant to challenge infection while those that were not exposed will succumb to the challenge (Kocan 1996, 1997).

o Virological examination of fish

During this project fish will be examined for the presence of viral hemorrhagic septicemia virus (VHSV) by conventional cell culture plaque assay as well as by a novel reverse-transcriptase, polymerase chain reaction (PCR) assay. Kidney and spleen tissues will be removed from 60 individuals selected at random. These tissues will be processed in 5-fish pools using standard techniques for the isolation and identification of VHSV (Fish Health Section, 1994). The tissue

pools will also be tested by PCR assay using a set of nested primers specific for nucleotide sequence within the nucleoprotein gene of VHSV(Winton & Batts, unpublished data).

o Serological examination of fish

Fish will be examined for the presence of specific serum (plasma) antibodies against VHSV by conventional virus neutralization assay. Blood plasma samples will be obtained from 60 individuals selected at random at the time of collection. Dilutions of the plasma will be reacted with equal volumes of a VHSV suspension and the mixtures titered using standard methods for detection of anti-viral fish antibodies (Fish Health Section, 1994). These data will be used to plot the change in plasma-neutralizing antibodies over time as the fish age.

o Correlation with recruitment

Data collected on the disease history and condition of juvenile herring from within Resurrection Bay during FY 2000 - 2002 will ultimately be correlated with recruitment of these age classes. Although this project will be completed before these fish recruit, the predictions made as a result of data collected now can be compared to the normal recruitment data collected by ADF&G each year. Thus, this study will end in 2002, but will still be accruing data until 2006.

If disease has a significant impact on a population, it should be reflected in the recruitment size at years 3 and 4. Although it is recognized that other factors such as predation and nutrition also play a role in survival, there is a high probability that predation will be greatest on disease debilitated individuals, and that poor nutrition will affect diseased individuals to a greater extent than healthy individuals.

References

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Fish Health Section (1994) Suggested procedures for the detection and identification of certain fish and shellfish pathogens. 4th ed. J. Thoesen (ed). Amer. Fisheries Soc., Bethesda, MD.

Hershberger, PK, RM Kocan, NE Elder, TR Meyers, JR Winton (1999) Epizootiology of viral hemorrhagic septicemia virus in Pacific herring from the spawn-on-kelp fishery in Alaska, USA. Dis. Aquat. Org. (in press).

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Kocan, RM and JE Hose. (1997) Correspondence between laboratory and field observations of sublethal damage in marine fish larvae: Lessons from the effects of the *Exxon Valdez* oil spill on Prince William Sound herring. pp 167-176. In: "Chemically Induced Alterations in Functional Development and Reproduction of Fishes." Rolland RM, Gilbertson M, Peterson RE, eds. SETAC Press, Pensacola FL.

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Kocan, R.M., and J.R. Winton. 1997. Laboratory challenge of Pacific herring with and without stressors. Section II in: Marty, G.D, et al. Investigations of disease factors affecting declines of Pacific herring populations in Prince William Sound. Exxon Valdez Oil Spill Restoration Project Annual Report (Restoration Project 96162), Alaska Department of Fish and Game, Anchorage, Alaska. 28 pages.

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Kocan RM, Hershberger P, Mehl T, Elder N, Bradley M, Wildermuth D, Stick K (1998) Pathogenicity of *Ichthyophonus hoferi* for laboratory-reared Pacific herring *Clupea pallasi* and its early appearance in wild Puget Sound herring. Dis. Aquat. Organisms 35:23-29

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Talbot, G.B. and S.I. Johnson 1972. Rearing Pacific herring in the laboratory. Progressive Fish Culturist. 34: 1-7.

Wedemeyer, G.A. and D.J. McLeay. 1981. Methods for determining the tolerance of fishes to environmental stress. Stress and Fish, A.D. Pickering, (ed). pp. 247-275. New York, Academic Press.

C. Cooperating Agencies, Contracts and other agency assistance

No outside contracts other than with the Seward SeaLife Center are anticipated. Collaboration and assistance by personnel and facilities of the Sea Life Center and U.S. Geological Survey, Biological Resources Division (USGS-BRD) Seattle, WA will continue throughout the project period.

SCHEDULE

A. Measurable Project Tasks for FY 00

FY 00 thru FY '01

Oct. '99 to May '00:	o Develop protocols and set up rearing facilities at ASLC
January '00	o Attend 11th anniversary of EVOS (Anchorage, AK)
June '00 - Sept '00	o Collect immunity and condition data on age-0 herring
April '01	o Collect post-winter data on Resurrection Bay herring
June '01 - Sept. '01	o Collect fish, sample tissues, plasma, etc. (year -2)
	o Continue laboratory monitoring of herring at ASLC
	o Begin data analysis of juvenile herring disease status
April '02	o Collect post-winter data on Resurrection Bay herring (yr -2)
	o Compare neutralization antibodies over time
	o Complete data analysis of summer's field/lab collections
Dec. '01 to April '02	o Write up and analyze data for annual report and Workshop
January 2003:	o Present FY '00-'02 findings at Workshop in Anchorage

B. Project Milestones and Endpoints (FY 00-02)

1. Assemble and test collection gear, pack for transport, arrange for specimen shipment to other lab and finalize protocol design (Jan '00 - May '00)

2. Collect herring and sandlance; transport to SLC; collect tissues and plasma from juvenile herring and sandlance for VHS culture (June '00 - Sept '00)

3. Assay tissues, water and plasma from age-0 herring. Determine mortality rate, immune status and condition factor of fish from June - Sept '00. (Sept '00 - Feb '01)

4. Sample over wintered fish for disease status, immunity and condition factor (April '01)

5. Assay plasma and tissue samples for VHS antibody and virus RNA (May '01 - June '01)

6. Repeat #'s 2 - 5 for FY 2001 - 2002

7. Complete data analysis, prepare final report and manuscripts; deliver results at annual workshop in Anchorage (Oct '01 - March '02)

C. Completion Date

Report preparation (FY 00 -> 02)

Annual report for FY-00	-	April. '01
Annual report for FY-01	-	April. '02
Final report for FY-'00 -'02	-	April. '03

Publications and Reports

Annual Report to Trustees for FY 00; January, 2001

Final Report to Trustees for FY 00-02; April, 2003

Kocan, RM, JE Hose, ED Brown & TT Baker (1996). Herring embryo (*Clupea pallasi*) sensitivity to Prudhoe Bay petroleum hydrocarbons: Laboratory evaluation and in situ exposure at oiled and unoiled sites in Prince William Sound. Can. J. Fish. & Aquat. Sci. 53: 2366-2375.

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Kocan, RM, M Bradley, N Elder, T Meyers, W Batts, J Winton (1997) The North American strain of viral hemorrhagic septicemia virus is highly pathogenic for labortory-reared Pacific herring (*Clupea pallasi*). J. Aquatic Animal Health. 9: 279-290.

Kocan, R., Hershberger, P., Mehl, T., Elder, N., Bradley, M., Wildermouth, D., Stick, K. (1999) Pathogenicity of *Ichthyophonus hoferi* for laboratory-reared Pacific herring (*Clupea pallasi*) and its prevalence in wild Puget Sound herring. Can. J. Fish. Aquat. Sci. 35:23-29.

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Professional Conferences

SEATAC Annual Conference; San Francisco, CA. November 1997

Pathogens and Diseases of Fish in Aquatic Ecosystems; Portland, OR June 1997
Two posters: Ichthyophonus and VHSV in herring

EVOS Annual Workshop; January 1998
Data from FY97

Puget Sound Research 1998
Seattle Conference Center, Seattle, WA March 12-13, 1998
Poster on herring diseases of the north Pacific

10 Anniversary Symposium of the Exxon Valdez Oil Spill
March 23-26, Anchorage, AK

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The (USGS-BRD) will contribute Dr. Winton's and Nancy Elder's salaries as well as space and equipment at the Seattle Laboratory and at Marrowstone Island Field Station, Nordland, WA. It is anticipated that most of the serology and PCR work would be done by Dr. Winton's group, induced VHS epizootics and challenge infections would be carried out at the ASLC.

Statistical consultation (project design / data analyses) will be obtained through the UW Center for Quantitative Science. Computer services (data entry, data analysis, word processing) will be provided by SOF and USGS. Histological processing of tissue samples will be carried out in part by Dr. Ted Meyers (ADF&G, Juneau, AK) as well as histopathological evaluation of tissues from experimental infections. Cell culture, virology and molecular biology facilities will be provided by USGS-BRD, Seattle, WA and U of W. Filtered seawater facilities for herring studies are available at the Alaska Sea Life Center (Seward, AK) and at the Marrowstone Island Field Station (Nordland, WA).

ENVIRONMENTAL COMPLIANCE

The National Oceanic and Atmospheric Administration (NOAA) is the lead federal agency for National Environmental Policy Act (NEPA) compliance for this project. This project has been granted categorical exclusion because it is essentially a laboratory study without environmental consequences. Permits needed for work in the State of Washington are granted by Washington Dept. of Fish & Game to the Univ. of Washington (R.M. Kocan, P.I.). Collection of 0-age herring in Alaska will be done under contract to the ASLC under a scientific collector's permit issued to R.M. Kocan and ADF&G. Animal Care Committee approval of the study has been granted at the Univ. of Washington. Collaboration with Dr. Gary Marty (UC Davis) will be ongoing and coordinated with his adult spawner disease project.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

N/A

PERSONNEL

Richard M. Kocan, Ph.D.
Over the past 12 years Dr. Kocan has had extensive experience with petroleum induced toxicity in aquatic organisms and since 1990 has been actively involved in the *Exxon Valdez* oil spill studies in Prince William Sound and has served as a peer reviewer for salmonids, rockfish, shellfish and herring during the Damage Assessment and Restoration phases of the program, as well as an expert witness for the State of Alaska and NOAA. From 1990 to 1993 he worked with the Alaska Department of Fish & Game in Cordova as a subcontractor on Herring Sublethal Effects (project #11), studying embryo-larval damage in Prince William Sound. He also worked on oil related problems in Puget Sound associated with near-shore damage and evaluation of oil originating from several shore-based oil operations. These include the Cherry Point shoreline where Texaco, BP Petroleum, ARCO and Intalco Aluminum Co. are located, as well as Fidalgo Bay, where Texaco has a transfer dock and refinery. These studies were originated by the State of

Washington and the Lummi and Klallam Indian Tribes and were funded by both the State and the various industries. Since 1995 Dr. Kocan has been PI on a Restoration Project (#s 95162-98162) dealing with disease factors affecting herring populations in PWS and Puget Sound. He has successfully reared herring from egg to 2-years-old and used these fish in disease studies requiring pathogen-free fish.

In 1985, prior to working on oil related problems in the Pacific North West, Dr. Kocan spent several months studying with Drs. Westernhagen and Rosenthal at the Biologische Anstalt Helgoland in Germany. There he worked on cod, sole, flounder, herring and turbot embryos and larvae which had been exposed to petroleum contaminated seasurface microlayer in the Baltic and North Seas.

Over the years Dr. Kocan has developed techniques for "on site" exposure of fish embryos in contaminated marine waters, laboratory cultivation of herring from egg to adult as well as laboratory evaluation of sediments for toxicity to marine vertebrates and invertebrates. He has access to flowing seawater research facilities at the University of Washington, the USGS field station on Marrowstone Island, Washington and has discussed the use of the new Alaska Sea Life Center with the director.

Dr. Paul Hershberger, Research Associate.

Ph.D. University of Washington School of Fisheries 1998. Experience with toxic marine algae, herring diseases, field operations, statistical analyses and on-site Prince William Sound experience with pound fishery (2 seasons) and juvenile herring diseases in Puget Sound. Currently working on environmental effects causing declines in Puget Sound's largest herring stock (Cherry Point) funded by the Washington Dep't of Natural Resources. Four years experience with herring studies at the Marrowstone Island Field Station (Nordland, WA) and training in fish pathogen PCR techniques at the USGS-BRD laboratory, Seattle, WA.

Key people (other than P.I.'s)

Nancy Elder, Fish Biologist; USGS-BRD, Seattle, WA. Four years experience with herring disease studies under the direction of Dr. James Winton and Dr. Richard Kocan. Currently the Biologist-in-charge at the Marrowstone Island Field Station and responsible for fish cell culture and virus diagnosis funded by 97162.

Relevant Publications

Batts, W.N., C.K. Arakawa, J. Bernard, and **J.R. Winton.** 1993. Isolates of viral hemorrhagic septicemia virus from North America and Europe can be detected and distinguished by DNA probes. Diseases of Aquatic Organisms 17: 67-71.

Kocan, RM, H v Westernhagen, ML Landolt and G Furstenberg. 1988. Toxicity of sea-surface microlayer: II. Effects of hexane extract on Baltic herring (*Clupea harengus*) and Atlantic cod (*Gadus morhua*) embryos. Marine Environ. Res. 23:291-305.

Kocan, RM and ML Landolt. 1990. Use of herring embryos for *in situ* and *in vitro* monitoring of marine pollution. In: S.S. Sandhu (ed.), *In Situ* Evaluation of Biological Hazards of Environmental Pollutants. Environm. Sci. Res. pp. 49-60.

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Date: 7 April 1999

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United States Department of the Interior

U.S. GEOLOGICAL SURVEY

Western Fisheries Research Center
6505 NE 65th St., Seattle, WA 98115

12 April 1999

Dr. Richard Kocan
School of Fisheries
University of Washington
Box 355100
Seattle, WA 98195

Dear Dr. Kocan,

This letter is to formally confirm our commitment to collaborate with you in accomplishment of your proposed research on viral hemorrhagic septicemia (VHS). As part of the Department of Interior, the Western Fisheries Research Center is extremely interested in your proposal because the North American strain of viral hemorrhagic septicemia virus is a significant pathogen of several marine fish species and is listed among the pathogens of concern for Pacific salmon in the western United States. Your work promises to expand significantly, our understanding of the epizootiology of this disease.

Our newly constructed research laboratories in Seattle and at Marrowstone Island include wet and dry laboratory spaces in which work on VHS virus can safely be carried out. As you are aware, we have considerable experience in conducting work with this virus and other salmonid pathogens. These facilities will be available for your research should the project be funded. I have attached a more detailed facilities statement for your use. In addition, we will offer in-kind technical assistance needed to acomplish this work.

If there is anything else I can do to be of assistance, please feel free to ask.

Sincerely,

James R. Winton, Chief
Fish Disease Section

FACILITY STATEMENT

U.S. Geological Survey
Western Fisheries Research Center
6505 NE 65th Street, Seattle, WA 98115

The Western Fisheries Research Center in Seattle represents a state-of-the-art center for work on infectious diseases of fish. Facilities available include over 16,000 square feet of new dry laboratory space for virology, cell culture (including monoclonal antibody production), bacteriology, immunology, histology, parasitology, and molecular biology. The laboratory also houses a new 9,000 square foot wet laboratory supplied with pathogen-free fresh water to 20 individual bays (each with temperature control from 4-25°C) containing a total of more than 300 tanks of various sizes. The laboratory effluent is treated with chlorine gas. Within the dry lab complex is a special, restricted access Biosafety Level 3 laboratory containing isolated dry and wet laboratories for work with exotic fish pathogens. Also in the dry lab are a walk-in cold laboratory (4°C), walk-in cold storage (4 and -20°C), fluorescent microscopy rooms, a common computer room and an animal care facility meeting NIH guidelines. The laboratory has 2 ultracentrifuges, 4 refrigerated centrifuges, 4 refrigerated microfuges, more than 10 PCR machines, automated DNA sequencer, DNA synthesizer, peptide synthesizer, pulsed-field, protein, and nucleic acid electrophoresis equipment, 3 spectrophotometers, scintillation counter, 5 chemical fume and 10 laminar flow hoods, 7 ultrafreezers, 5 research microscopes, computer network, and other large and small equipment items commonly found in microbiology, immunology and molecular biology laboratories.

The Marrowstone Marine Field Station is located on Marrowstone Island at the northern entrance to Puget Sound, where the currents from the Strait of Jan de Fuca enter from the Pacific providing a source of exceptionally high seawater quality. The station consists of: a dry laboratory that includes space and necessary equipment for chemical analysis, tissue culture, virology, bacteriology, physiology and offices for researchers; 2 large wet labs with continuous-flow, pathogen-free seawater at either ambient or controlled temperatures; a 3-story house used for office, library, and dormitory space; and support facilities such as pumphouse and shop.

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
January 1, '00 - Sept 30, '02

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$0.0
Travel		$0.0
Contractual		$76.7
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$76.7
General Administration		$5.4
Project Total	$0.0	$82.1
Full-time Equivalents (FTE)		1.8
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		$102.0	$105.9		

Dollar amounts are shown in thousands of dollars.

Comments:

FY00

Project Number: 00562
Project Title: Effect of VHS on Overwinter Survival of Juvenile Herring in Resurrection Bay, AK: Implications for Year-Class Survival
Agency: AK Dept of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:

4/13/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
January 1, '00 - Sept 30, '02

Budget Category:		Proposed FFY 2000						
Personnel		$ 50.2						
Travel		$ 7.9						
Contractual		$ 1.4						
Commodities		$ 1.4						
Equipment		$ -	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$ 60.9	FFY 2001	FFY 2002				
Indirect @ 26%		$ 15.8	$95.3	$99.0				
Project Total		$ 76.7						
Full-time Equivalents (FTE)		1.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources		$16.0	$16.0	$16.0				

Comments: Indirect costs include the standard off-campus overhead rates and applications for the University of Washington (26%)

First year costs based on 9 months (Jan - Sept '00); out-years based on 12 months each.

UW recommended 4% annual increase calculated for out-years.

USGS-BRD, Marrowstone Island Field Station provides computer stations, phones, FAX and specimen archives. On-site facilities and are being supplied to the project by USGS (equivalent value of $6.25K for office/equip.).

USGS-BRD lab technician time donated @ 50% over 3 months; equivalent to $9.7K + benefits.
UW Fisheries provides computing and communications equipment, photography, and libraries (~$14K).

ADF&G Administrative costs of 7% have **NOT** been included in these calculations

Alaska SeaLife Center bench fees etc have **NOT** been included in these calculation (see attached requiments)

FY 00

Project Number: 00562
Project Title: Effect of VHS on Overwinter Survival of Juvenile Herring in Resurrection Bay, AK: Implications for Year-Class Survival
Agency: AK Dept of Fish and Game
Name: R. Kocan, University of Washington

FORM 4A
Non-Trustee
DETAIL
4/13/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
January 1, '00 - Sept 30, '02

Name: R. Kocan, University of Washington

Personnel Costs: University of Washington School of Fisheries			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FFY 1998
	Kocan, RM	PI, project manager; design experiments, analyze data; write reports; publish data	3.6	6,977	0	25.1
						0.0
						0.0
						0.0
	Paul Hershberger (post doc)	Post Doctoral Fellow; collect field data, manage lab studies; analyze data	9.0	2,783	0	25.0
						0.0
						0.0
						0.0
	Nancy Elder (cell culture - USGS biologist)		1.5	0		0.0
		Virus assays; immunity studies at Marrowstone Island)				0.0
						0.0
						0.0
		Subtotal	14.1	9,760	0	
					Personnel Total	$50.1

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FFY 1998
	Seattle <-> Seward	450	4	180		1.8
	Seattel <-> Anchorage	450	2	10		0.9
						0.0
						0.0
	housing (Seward) for 4 months (community appartment for all personnel @ $1K/mo)					4.0
	per diem (food costs) @ 300 / month ($100/mo per person)					1.2
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	7.9

FY 00

Page 3

Project Number: 00562
Project Title: Effect of VHS on Overwinter Survival of Juvenile Herring in Resurrection Bay, AK: Implications for Year-Class Survival
Agency: AK Dept of Fish and Game
Name: R. Kocan, University of Washington

FORM 4B
Personnel
& Travel
DETAIL
4/13/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
January 1, '00 - Sept 30, '02

Name: R. Kocan, University of Washington

Contractual Costs:	Proposed FFY 1998
Description	
* Long distance	1.8
FAX	
photography	
postage	
graphics	
internet access	
Contractual Total	$1.8

Commodities Costs:	Proposed FFY 1998
Description	
cell culture media	
lab plastic ware	1.4
bovine serum	
oxygen	
film	
culture media	
Commodities Total	$1.4

FY 00

Project Number: 00562
Project Title: Effect of VHS on Overwinter Survival of Juvenile Herring in Resurrection Bay, AK: Implications for Year-Class Survival
Agency: AK Dept of Fish and Game
Name: R. Kocan, University of Washington

FORM 4B
Contractual & Commodities DETAIL

4/13/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
January 1, '00 - Sept 30, '02

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1998
			0.0
none	0		0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
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
Power Mac 7600 (SOF; U.W)	1
Power Mac 7600 (Marrowstone Island Field Station)	1
Publication Office - U.W. SOF computers/printers	1
Seawater sterilization system: filtered and sterilized @ 400gpm (Marrowstone Island)	1
Tissue culture hood; Marrowstone Island Field Station	1
Oxygen meter	1
pH meters	1

FY 00

Project Number: 00562
Project Title: Effect of VHS on Overwinter Survival of Juvenile Herring in Resurrection Bay, AK: Implications for Year-Class Survival
Agency: AK Dept of Fish and Game
Name: R. Kocan, University of Washington

FORM 4B
Equipment
DETAIL

Kenai River Streambank Habitat Utilization Study

Project Number:	00563
Restoration Category:	Research/ General Restoration
Proposer:	ADF&G – Habitat and Restoration
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	
Alaska SeaLife Center:	
Duration:	1st of 2 years
Cost FY 00:	$74.7
Cost FY 01:	$35.0
Geographic Area:	Kenai Peninsula
Injured Resource/Service:	Commercial Fishing; Recreation and Tourism; Juvenile salmonids

ABSTRACT

The Kenai River is one of Alaska's most productive natural resources, but because of intense development pressure and heavy public use, it is also one of Alaska's most threatened natural resources. The Alaska Department of Fish and Game (ADF&G) has received state and federal funding as well as EVOS criminal settlement funds to implement streambank restoration activities and acquire key habitats on the Kenai River. ADF&G has also received EVOS funds to prioritize and restore damaged public use sites on the river for the benefit of injured fish resources and recreational services. Streambank rehabilitation has been accomplished with a new approach called soil bioengineering which uses coir (coconut) fabrics and rolls, live and dead vegetation, seedlings, and other measures to stabilize streambanks and provide cover for fish. This technique has gained prominence in applications throughout the U.S. and the world. Bioengineering provides immediate cover for fish while promoting natural revegetation and stabilization of streambanks to prevent erosion. However, even with hundreds or thousands of such projects being installed, extremely little has been done to assess actual benefits to fish.

The purpose of this study is to compare how bioengineered streambank projects function compared to natural and disturbed (impacted) sites in terms of providing habitat for fish – specifically, salmon. The results will document and evaluate habitat variables and fish use of restoration projects with the intent of evaluating and improving installation methodologies, both within Alaska and throughout the world. Results will be useful for permitters, landowners, contractors and regulators in the Kenai River drainage and elsewhere.

INTRODUCTION

The Kenai River in southcentral Alaska is an exceptionally productive system, best known for its trophy chinook salmon that exceed 95 pounds and for the millions of red salmon that return to its waters each year. These abundant fishery resources provide the foundation for long-standing commercial, sport and subsistence harvests and a rapidly expanding tourism industry on the Kenai Peninsula. Annually, the Kenai River is responsible for contributing over $78 million to Alaska's economy.

Situated on the Kenai Peninsula, the Kenai River is approximately 140 miles by road, or 70 miles by air, from Anchorage, the state's largest city. The river itself is 67 miles long and drains a watershed of approximately 2200 square miles. It is, for tens of thousands of Alaskan residents and visitors alike, an essential recreation destination. The Kenai River is widely known for its chinook salmon populations, which are among the largest of this species in the world. Additionally, the Kenai River produces millions of sockeye, coho, pink and chum salmon. Over the past 10 years, the Kenai River system has annually produced approximately 40 percent of the commercial sockeye salmon harvest in Cook Inlet and 30 percent of the commercial chinook salmon harvest. During this period, the chinook harvest ranged from 8,000 to 40,000 fish and the sockeye harvest ranged from 2.5 to 9.5 million fish. Combined, sport anglers and commercial fishermen provide as much as $78 million to the state's economy each year (Liepitz, 1994).

However, many indicators suggest that that the Kenai River is in trouble. Sportfishing on the river has almost doubled from 1981 to 1994, climbing from 129,076 angler days to 340,904 angler days, respectively (Howe, 1995). This has led to a loss of vegetation and increasing rates of erosion as more anglers trample streambanks in search of fishing opportunities. Overcrowding and trespass have exacerbated user conflicts and resulted in more garbage and human waste being deposited along the river's shores. Private lands are being subdivided and developed at an alarming rate. And, fisheries allocation issues continue to erupt as use demographics change. The riparian zone, the transitional area that lies between the river's channel and the uplands, provides important fish and wildlife habitat and plays a major role in the hydrology of the watershed by helping to control floods and erosion. This vegetated area functions as a buffer and filter system between upland development and the river, maintaining water quality by absorbing nutrients, accumulating and stabilizing sediments, and removing heavy metals and pollutants that result from urban development and enter the river as surface runoff. It is also the area where a significant portion of the Kenai River's sportfishing and other recreational activities are concentrated.

Fish, particularly juvenile salmon, depend heavily on the riparian zone for food, cover and migration. Undercut streambanks with overhanging vegetation provide hiding places for fish to avoid predation, to feed and to grow. Slower water velocities allow juveniles to conserve energy and maintain their orientation along the perimeter of the mainstem channel.

Concern about streambank degradation is not new. Over 15 years ago, Burger, et al (1983) performed a comprehensive investigation of juvenile and adult salmon habitat needs in the Kenai River and commented on the impacts of some riverbank alterations. They reported that juvenile chinook salmon longer than 50mm were the predominant species found in mainstem rearing areas and that most of these were captured where the average water velocity was 12 cm/sec. A total of 80% of the juveniles were captured where the velocity was less than 33 cm/sec and 75% were captured in "facing water velocities" of 18.3 cm/sec. Bendock and Bingham (1988)

concluded that any alterations to Kenai River streambanks should be made with considerations of the nearshore habitat for juvenile chinook salmon. Reports from other areas have also demonstrated the importance of low-velocity, nearshore habitat with cover for juvenile chinook salmon in mainstem reaches of the river.

King and Hansen (1998) studied the distribution and movement of sockeye salmon anglers who fished from shore and assessed the impacts of the anglers on riparian areas. Liepitz (1994) and Larsen et al. (1997) inventoried nearshore juvenile salmon rearing habitat along the Kenai River mainstem to assess the effects of human-induced riverbank alterations. Liepitz (1994) concluded that over 11 percent of available chinook salmon rearing habitat had been impacted by bank trampling, vegetation denuding, and structural development along the riverbanks. Consequently, there has been increased effort to design and implement streambank revegetation and protection measures that will protect, restore and enhance fish habitat.

ADF&G, recognizing the importance of this system, has devoted significant efforts toward cataloging, protecting and rehabilitating vital habitats that support the river's resources. In 1993, the ADF&G initiated the first comprehensive study of streambank development and land use on the Kenai River in order to assess effects on chinook salmon rearing habitat (Liepitz, 1994). Shortly thereafter, the department received $3 million in Exxon Valdez Oil Spill (EVOS) criminal settlement funds, and a $1 million congressional appropriation (passed through the National Marine Fisheries Service) to implement streambank restoration activities and acquire key habitats on the Kenai River. During 1996-1998, the ADF&G also received funding from the EVOS Trustee Council to prioritize and restore damaged public use sites on the river for the benefit of injured fish resources and recreational services.

The ADF&G has participated in two programs since 1995: 1) the "State/Federal Joint Matching Funds Kenai River Restoration and Protection Program" that provides cost-share funding to public and private landowners to restore and protect salmon habitat damaged by land development and streambank trampling; and, 2) the *Exxon Valdez* Oil Spill (EVOS) "Kenai River Habitat Restoration and Recreation Enhancement Project", designed to restore damaged riparian habitat on public lands of the Kenai River. Through 1998, these programs have contributed to the restoration of approximately 12,500 linear feet of riverbank and the protection of approximately 17,000 feet of riverbank. One important aspect of this work yet to be evaluated is whether restoration of damaged riverbanks has resulted in increased fish habitat and use by juvenile salmon, particularly chinook salmon.

This study is designed to:

a) Compare and evaluate the use of natural, disturbed (damaged) and restored streambank habitat by juvenile salmonids, and
b) Compare and evaluate nearshore habitat variables among restoration projects in the Kenai River with both disturbed and undisturbed nearshore habitats.

The purpose of the study will be to compare how bioengineered projects function in comparison to natural and disturbed (impacted) sites in terms of providing habitat for fish – specifically, salmon. The results will document and evaluate habitat variables and fish use of restoration projects with the intent of advancing installation methodologies, both in Alaska and throughout the world.

Research that is funded according to this proposal will be the second year of a 2-year study that will be initiated by ADF&G during FY1999. Study approach and methodologies for FY 2000 will be improved as a result of information and experience gained during 199. The FY1999 work will be funded largely from the Capitol Improvement Project fund for habitat revegetation projects on the Kenai River.

NEED FOR THE PROJECT

A. Statement of Problem

The EVOS Restoration Program, as well as state, federal and private sources have provided funding to implement streambank restoration projects on the Kenai River. Three million dollars from Exxon Valdez Oil Spill (EVOS) criminal settlement funds and a $1 million congressional appropriation have been dedicated to implement streambank restoration activities and acquire key habitats on the Kenai River. During 1996-1998, the ADF&G also received funding from the EVOS Trustee Council to prioritize and restore damaged public use sites on the river for the benefit of injured fish resources and recreational services. State and Federal matching funds provide cost-share projects for public and private landowners to restore and protect salmon habitat damaged by land development and streambank trampling, and the EVOS "Kenai River Habitat Restoration and Recreation Enhancement Project" was designed to restore damaged riparian habitat on public lands of the Kenai River.

One important aspect of this work yet to be evaluated is whether restoration of damaged riverbanks has resulted in increased fish habitat and use by juvenile salmonids. There has been no evaluation or monitoring of these projects and there has been no verification that habitat which has been purchased actually provides habitat for young fish. This study is designed to evaluate the effectiveness of revegetation projects to verify that habitat is provided and that the habitat provides protection for the resources as intended.

Results from this research will be used to improve the design and construction of future streambank revegetation projects in the Kenai River drainage and elsewhere. Results will be useful for planners, permitters, landowners, regulators and contractors.

B. Rationale/Link to Restoration

The Kenai River was impacted by the Exxon Valdez oil spill when commercial fisheries were closed and a large influx of sockeye salmon resulted in increased sportfishing pressures that continue even today. The Kenai River also supports injured pink and sockeye salmon and Dolly Varden. During 1996-1998 the EVOS Trustee Council funded the installation of restoration projects that are to be evaluated by this study.

C. Location

This project will be performed in the middle and lower reaches of the mainstem of the Kenai River.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Communication and information exchange with local communities will be expedited through the existing infrastructure of the consolidated Kenai River Center. This Center is an award-winning multi-agency permitting, information and education resource that allows agencies to work cooperatively with the public to protect and restore the Kenai River, its watershed, and its fish and wildlife resources. The agencies include: Kenai Peninsula Borough, Planning Department, Alaska Department of Fish & Game, Habitat and Restoration Division and Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation (State Parks).

Landowners will be contacted directly to ask permission to perform the studies on their properties and to inform them about the research project, progress and results.

PROJECT DESIGN

A. Objectives

The goals of this study are to:

a) Compare and evaluate nearshore habitat variables among restoration projects in the Kenai River with both disturbed (damaged) and undisturbed (natural) nearshore habitats, and
b) Compare and evaluate the use of natural, disturbed and restored streambank habitat by juvenile salmonids.

The objective of the project is to test the hypotheses that there is no significant difference in the mean habitat variables among the restoration project locations and disturbed and undisturbed nearshore habitats.

The purpose or application of the results from this study is to improve design and implementation of future projects in the Kenai River and to export the methodologies to other locations.

B. Methods

There will be two parts to this study. One part will be a quantitative evaluation of the fish habitat variables and fish habitat utilization of the restoration projects. The second part will support the first part, including a documentation of the history of the projects and include a qualitative visual description of the restoration projects to assess whether they are functioning as they were intended and designed.

Study Site Selection:
Four treatments (or habitat types) will be evaluated:

- Undisturbed: natural riparian habitat
- Disturbed: anthropogenic effects; i.e., study sited in this treatment may be/could be candidates for a revegetation and/or protection project
- Cabled spruce trees: streambank is protected with cabled spruce trees only
- Bioengineered: streambank is revegetated with brush layering and similar methods

Study sites will be selected according to the following standards:

A. All four treatments must be equally represented within a similar river reach.
B. All four treatments must be distributed approximately equally on the same side of the river and with similar channel morphology features; e.g., inside/outside of bend.
C. A study site must include at least 18 meters with the same treatment.

Number of Study Sites:
A total of 36 study sites will be visited to obtain field measurements. Study transects will be located at 3, 6, 9, 12 and 15 meters along each study site for a total of 180 transects.

Field Data Collection:
Field data collection will be accomplished in two stages that will be organized according to tasks.

Stage 1 – Habitat Variables will be completed in early summer during low discharge conditions. Habitat variables such as undercut banks, cover and substrate will be visible at this time and easier to measure than when inundated by silt-laden water. Measurements will be made along five data collection transects. Transects will begin at the edge of the ordinary high water (OHW) mark extend perpendicular from the shore. Habitat variable measurements will include:

- Vegetative Cover below OHW:
  Instream vegetative cover below OHW for salmonids includes both "Fine Stem Debris Cluster" and "Other Woody Debris". A cross-sectional measure of the Vegetative Cover below OHW beneath the transect will be obtained.

- Undercut Bank: Depth of an undercut bank will be the greatest horizontal distance measured from a line that is vertical to the outer margin of the upper lip of the opening.

- Distance below OHW: Distance to the substrate from OHW will be measured at 1.0 meter from the edge of the shoreline at OHW along the transects located at 3, 6, 9, 12 and 15 meters.

Stage 2- Fish and Water Column Variables will be completed during the first week of August. The object is to complete these measurements in a short time period during normal high-water conditions to minimize potentially-confounding effects of variable discharge conditions. Tasks will include:

- Fish Trapping: Fish will be caught with standard "minnow" traps (all will have identical dimensions). Fishing time will be 30 min. Traps will be placed between 0.5 and 1.0 meters from the edge of the water under the transects at 3, 6, 9, 12, and 15 meters. Numbers of fish within each species will be recorded.

- Fish Length Measurements: Fish will be measured to the nearest mm, TL. All individuals from the trap at the 9-meter transect will be measured.

- Water Depth: Depth of the water will be measured below the transects located at 3, 9 and 15 meters at 0.0, 0.25, 0.5 and 1.0 meters from the edge of the water.

- Water Velocity: The water velocity will be measured below the transects located at 3, 9 and 15 meters at 0.0, 0.25, 0.5 and 1.0 meters from the edge of the water following standard USGS water measuring techniques.

- Overhead Cover: Live vegetation that is within 30 cm. of the water surface will be measured from the shore at OHW mark to the nearest mm (excluding tree trunks or downed logs) (Platts, et al., 1988; King and Hansen, 1999).

- Water Temperature: The temperature of the water will be measured below the transect located at 5 meters between 0.5 and 1.0 meters from the edge of the water.

- Water Turbidity: Water turbidity will be obtained from USGS Water Quality records.

DATA REDUCTION AND QUALITY ASSURANCE PROCEDURES:

Habitat Variables:
The average value of each habitat variable will be calculated for each Study Site.

Fish and Water Column Variables:
The average number of each species of fish caught will be calculated for each Study Site. The average length of the fish within each species will be calculated. The average water depth and velocity at 0.5, 1.0 and 1.5 meters from shore will be calculated for each Study Site.

Observational variability will be minimized by 1) designating and training the observers and 2) repeating observations to evaluate observer variability.

ANALYSIS

Objectives

To test the hypotheses that there is no significant difference in the mean habitat variable among the four streambank revegetation treatments. For each habitat variable, the detectable difference, power of the test and the probability of type I error are listed below. A Monte Carlo simulation was used to determine sample size and estimate power.

Habitat Variable	Detectable Difference	Power	Probability of Type I Error
Other Woody Debris	0.15	70%	0.10
Fish Catch per Unit Effort	0.30	87%	0.10
Depth	0.25	71%	0.10
Fine-Stem Woody Debris Bundle	0.25	74%	0.10
Fish length	0.15	91%	0.10
Overhead Cover	0.30	78%	0.10
Temperature	0.10	93%	0.10
Undercut Bank	0.25	82%	0.10
Water Velocity	0.25	82%	0.10

Data Analysis:

Analysis of variance with a nested treatment arrangement will be used to test for significant differences among treatments. The following model will be used for each habitat variable:

$$Y_{ijk} = \mu + \tau_i + \gamma_{ij} + \varphi_{ijk}$$

where:

μ = the overall mean

τ_i = Effect of the i^{th} treatment

γ_{ij} = Effect of the j^{th} site within the i^{th} treatment

φ_{ijk} = Effect of the k^{th} transect within the j^{th} site within the i^{th} treatment

Treatment is considered a fixed effect and both site and transect are considered random effects. All assumptions of the ANOVA will be tested and if necessary the appropriate transformation or nonparametric technique will be used.

C. Cooperating Agencies, Contracts and Other Agency Assistance

ADF&G will conduct this project. There are no "cooperating agencies" at this time, however, several agencies have already expressed support and interest in participating in one or more aspects of this study; including: USFWS Kenai Wildlife Refuge, Kenai Peninsula Borough, USGS and Alaska Department of Natural Resources. Their participation will be developed and they will be informed about the progress of the project.

This study will complement studies performed by other divisions within ADF&G, the Kenai Peninsula Bourough and the Kenai Wildlife Refuge. The first year of study and data collection for this project will be accomplished by ADF&G, H&R Division, during FFY 1999 as part of the Capitol Improvement Funding that has provided funds for the revegetation projects, but that funding is inadequate to accomplish two years of research. Results from a second year of study will be needed to validate results from the first year and the quality of data collection will be improved by applying lessons learned during the first year.

Education for cooperators, landowners and contractors will be provided through the design and permitting process and through the Kenai River Center in Soldotna.

SCHEDULE

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

Oct 1 – Dec 31:	Review methodology and results from FFY 1999 studies
Jan 1 – Mar 31:	Verify plan for FFY 00 studies
Apr 1 – Jun 30:	Perform data collection for habitat parameters during May Initiate data reduction and analyses
Jul 1 – Sep 30:	Perform data collection for fish and aquatic parameters during August Initiate data reduction and analyses

B. Project Milestones and Endpoints

May 2000 – Data collection for physical habitat parameters

August 2000 - Data collection for fish studies and water depth and velocity and habitat parameters

December 2000 – Complete data analysis and statistical treatments

April 2001 – Complete Draft Final Report

September 2001 – Complete revisions for Final Report

PUBLICATIONS AND REPORTS

No publications are planned for FFY 00, however, it is expected that publishable results will be obtained and incorporated in the final report. Results are also expected to be presented in poster form to assist with professional and landowner education.

PROFESSIONAL CONFERENCES

Results from this study are expected to be presented during the 2000 Annual Meeting of the American Fisheries Society that will be held August 20 - 24 in St. Louis, MO; and, during the International Erosion Control Association 31st Annual Conference & Trade Exposition that will be held in Palm Springs, California. Results are also proposed to be submitted to the Society of Ecological Restoration and American Society of Civil Engineers biannual conferences.

NORMAL AGENCY MANAGEMENT

The program that this research project is intended to evaluate is beyond the scope of normal agency management. It will however, provide essential information for all agencies, landowners, planners, contractors and permitters who are involved in similar restoration activities. Existing support comes from a combination of several funding sources that are nearly depleted and will soon be ending. A portion of these funds is being used during FY1999 to accommodate the first year of this study. Funding by the EVOS Trustee Council is being requested for the second of two years of field studies and for a final report.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project represents a logical extension of EVOS restoration efforts on the Kenai River. To date, the ADF&G has assessed the threat of potential impacts from land use development and public use, prioritized damaged sites for restoration, implemented an effective cost-share program with private landowners, managed EVOS-funded restoration of public lands and assisted in the acquisition of EVOS restoration parcels. All of these efforts have at one time or another been of significant relevance to the EVOS restoration program. As a consequence, many other agencies, local governments, private organizations and landowners throughout Alaska have begun implementing similar restoration projects. The final step in this process involves assessing just how successful the program has been in meeting its habitat objectives, and determining what measures are needed, if any, to ensure that future projects function more effectively. This information will extend the lessons learned from local efforts to an international audience.

PROPOSED PRINCIPAL INVESTIGATOR

William J. Hauser
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333 Raspberry Road
Anchorage, AK 99518

(907)267-2172
fax (907)267-2464
Email *BillH@fishgame.state.ak.us*

PRINCIPAL INVESTIGATOR

William J. Hauser has been an ADF&G Fisheries Biologist for 19 years. He is presently the Program Manager for EVOS Restoration Projects and the Assistant ADF&G Liaison. He has assisted with numerous fisheries development projects throughout the spill area. He served as the project biologist for a habitat improvement project on Campbell Creek. He also organized and coordinated four Alaska Fish Habitat Improvement Workshops and was a co-organizer for the 1994 Symposium for Aquatic Habitat Restoration in Northern Ecosystems.

BS – Zoology - University of Wisconsin, 1965
MS – Fish and Wildlife Management – Montana State University. 1968
PhD – Zoology – University of Maine, 1973

OTHER KEY PERSONNEL

Mark J. Fink has been an ADF&G Habitat Biologist for over 8 years. He was a co-investigator on an ADF&G study documenting cytochrome P-450 induction and histopathology in pink salmon from oiled streams in Prince William Sound. Additionally, he assisted in an EVOS TC funded restoration project identifying anadromous fish bearing streams on Afognak Island. He is currently the ADF&G spill response coordinator for southcentral and southwestern Alaska, and also co-chairs the State, Federal, Tribal Natural Resource Damage Assessment Trustee Working Group.

BS – Wildlife Biology – Oregon State University, 1981

Dean W. Hughes has been employed by the Alaska Department of Fish and Game (ADF&G) for 8 years. He was the Assistant Fisheries Program manager for ADF&G EVOS projects from 1991 to 1995. Since 1995, he has worked as a habitat biologist assisting landowners in developing and implementing riverbank protection and revegetation projects. He has overseen the budgeting, permitting and construction of over 150 habitat improvement and protection projects along the Kenai River. He participated in the 1997 309 study of the Kenai River that documented existing fish habitat and structural development along the entire Kenai River mainstem.

BS – Marine Science - University of South Carolina. 1982

Mark Kuwada - Habitat Biologist with the Alaska Department of Fish and Game for 19 years. Project Manager for: Federal OCS Oil and Gas Leasing Program, Susitna Hydroelectric Project, Bradley Lake Hydroelectric Project, Diamond Chuitna Coal Project. State Liaison to the federal government on USFWS Comprehensive Conservation Planning for Alaska Wildlife Refuges. ADF&G Response Coordinator, *Exxon Valdez* oil spill. ADF&G Title 16 permitting, southcentral Alaska and Kenai River. EVOS Habitat Protection Work Group and Restoration

Planning Work Group member. Project Manager on three EVOS-funded projects, including "Kenai River Habitat Restoration and Recreation Enhancement Project."

Pat Hansen is a Biometrician II for the Alaska Department of Fish and Game and she has provided biometrics assistance for a variety of fisheries studies on the Kenai Peninsula and other places in Alaska. She has previously provided biometrics support for several habitat evaluation studies to assess damage to streambanks on the Kenai River.

LITERATURE CITED

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2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000						
Personnel		$49.3						
Travel		$14.5						
Contractual		$1.5						
Commodities		$1.9						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$67.2			Estimated FY 2001	Estimated FY 2002		
General Administration		$7.5						
Project Total	$0.0	$74.7			$35.0			
Full-time Equivalents (FTE)		0.7						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY00

Prepared:

Project Number: 00563
Project Title: Kenai River Streambank Habitat Utilization Study
Agency: ADF&G

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRU_ . __ COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:			GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FY 2000
Name		Position Description					
							0.0
Fink	FBIII	Sub-Project Leader - Habitat		1.4	5.4		7.6
Hansen	BiomII	Project Biometrician		0.7	5.6		3.9
Hauser	FB IV	Project Leader/ Coordinator		3.0	7.5		22.5
Hill	FTIII	Project Technician		1.5	3.6		5.4
Hughes	FBII	Project Ldr - Kenai R. Restoration and Protection		0.7	5.2		3.6
Kuwada	FBIII	Sub-Project Leader - History and Description		1.0	6.3		6.3
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		8.3	33.6	0.0	
						Personnel Total	$49.3

Travel Costs:			Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 2000
Description							
Perdiem =	50	Lodging = $100.00 $150.00					0.0
							0.0
Anchorage - -Kenai RT		Fink	0.2	2	9	0.2	2.2
		Hansen	0.2	1	1	0.2	0.4
		Hauser	0.2	2	11	0.2	2.6
		Hill	0.2	1	9	0.2	2.0
		Hughes	0.2	2	3	0.2	1.0
		Kuwada	0.2	2	9	0.2	2.2
Vehicle Mileage		500 miles @ 0.30					0.2
Vehicle Rental		10 days @ $50					0.5
Anchorage - St. Louis - Amer Fish Society Ann Meeting			0.7	1	5	0.2	1.7
Anchorage - Palm Springs - Int. Erosion Control Assoc. Ann Meeting			0.7	1	5	0.2	1.7
						Travel Total	$14.5

FY00

Prepared:

Project Number: 00563
Project Title: Kenai River Streambank Habitat Utilization Study
Agency: ADF&G

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:				
Description				Proposed FY 2000
	Rate	Number	Cost	
Film Processing	20	10	200	0.2
Equipment calibration and servicing - Flow meters	400	3	1200	1.2
Postage	20	3	60	0.1
When a non-trustee organization is used, the form 4A is required.			**Contractual Total**	$1.5

Commodities Costs:				
Description				Proposed FY 2000
	Number	rate	Cost	
Minnow Traps	20	25	500	0.5
Hip Boots	3	100	300	0.3
Bait	2	25	50	0.1
Rain Gear	2	200	400	0.4
Outboard Fuel	100	1.5	150	0.2
Film	20	8	160	0.2
Measuring rods	4	50	200	0.2
			Commodities Total	$1.9

FY00

Prepared:

Project Number: 00563
Project Title: Kenai River Streambank Habitat Utilization Study
Agency: ADF&G

FORM 3B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRU..... 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	Inventory Agency

FY00

Project Number: 00563
Project Title: Kenai River Streambank Habitat Utilization Study
Agency: ADF&G

FORM 3B
Equipment
DETAIL

Prepared:

Harbor Seals on Glacial Ice in PWS: Habitat Use, Trophic Interactions and Abundance

Project Number:	00564
Restoration Category:	Research, Monitoring
Proposer:	Kathryn J. Frost, ADF&G
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	none
Alaska Sea Life Center:	
Duration:	1st year, 5-year project
Cost FY 00:	$122,400
Cost FY 01:	$225,000
Cost FY 02:	$175,000
Geographic Area:	Prince William Sound
Injured Resource:	Harbor Seals

ABSTRACT

This project is the first year of a 3-year project to study harbor seals on glacial ice haulouts in Prince William Sound (PWS). During 1989-1999, the EVOS Trustee Council funded studies of harbor seals using rocky intertidal haulouts in central and southern PWS. The primary focus of those studies was to monitor population status, document movements and important habitat, and investigate whether food limitation caused the population decline that occurred during 1984-1999. To address these issues, we flew annual surveys; instrumented seals with satellite-linked time-depth recorders; studied temporal and demographic changes in diet by analyzing fatty acid signatures in blubber; and investigated annual changes in the body composition of pups and subadults. As part of this new project, we propose to conduct similar studies in glacial ice areas of PWS. The proposed project has complimentary components which can be done all or in part, including: 1) conduct aerial surveys of glacial ice haulouts during molting to determine abundance; 2) compare diet of these and other PWS seals using fatty acids analysis of blubber; 3) study body condition using D_2O equilibration; and 4) study movements, habitat use and site fidelity by instrumenting "glacier seals" with satellite tags. Special emphasis will be on pups and juveniles, the age groups most likely to be affected by changes in food availability.

INTRODUCTION

The *Exxon Valdez* oil spill (EVOS) occurred in Prince William Sound (PWS) in March 1989. Because harbor seals (*Phoca vitulina richardsi*) and their haulouts became oiled by the spill, harbor seal studies began almost immediately as part of the Natural Resources Damage Assessment (NRDA) program. These NRDA studies were conducted by the Alaska Department of Fish and Game (ADF&G), and included aerial surveys to quantify mortality and necropsies to document levels of hydrocarbons and tissue damage in oiled seals. Based on these investigations, it was estimated that more than 300 harbor seals (36% of the seals in oiled areas) died in PWS following the EVOS. As NRDA studies progressed, it also became clear that the harbor seal population throughout PWS was declining and had been doing so since at least 1984. Therefore, beginning in 1991 as NRDA studies neared completion, the Trustee Council funded a harbor seal restoration study in which ADF&G continued to monitor the trend of harbor seals in PWS and began to investigate the causes of the ongoing decline. These early restoration studies addressed a broad array of possible causes for the decline including disease, predation, human-caused mortality, reproduction, and food limitation.

Marine mammals and seabirds are apex predators in ecosystems in which fishes and cephalopods are important prey. As such, a strong relationship would be expected between predator populations and the abundance of fish stocks. This relationship is likely to be influenced by factors such as commercial fisheries and ecosystem changes (e.g., Beddington, et al. 1985; Springer 1993). In many parts of the world pinniped populations have increased as predicted after protection from over-exploitation (e.g., Olesiuk, et al. 1990; Shelton et al. 1995). However, large declines in populations of harbor seals and Steller sea lions (*Eumetopias jubatus*) have been documented in the Bering Sea and the GOA, including PWS (Pitcher 1990; Loughlin, et al. 1992). These declines occurred despite implementation of the 1972 Marine Mammal Protection Act (MMPA) which ended commercial hunting for pups and bounty payments for adults. Likewise, since the 1970's numerous species of seabirds have also declined in PWS. These unanticipated declines have prompted monitoring and assessment of marine mammal, seabird, and fish population trends, and perhaps most importantly, have furthered the idea of using predators as samplers of forage fish abundance (Duffy 1996; Roseneau and Byrd 1996).

In PWS, harbor seals are one of the most abundant and widely distributed marine mammals, hauling out and/or breeding at more than 50 sites. Since 1984 harbor seal numbers at a trend count area in central and eastern PWS have declined by about 60%, with only part of this decline attributable to the 1989 *Exxon Valdez* oil spill (EVOS) (Frost and Lowry 1994a, Frost et al. 1994). The decline in harbor seals was not limited to PWS, but also occurred in adjacent parts of the GOA (Pitcher 1990). An atmospheric "regime shift" causing changes in the availability of prey is considered the most likely cause for this observed decline, as well as that of other apex predators. Thus, understanding the diet of harbor seals and how they may depend on seasonal or area-specific concentrations of prey is not only needed in the management of harbor seals as a resource, but because harbor seals may also act as important indicators of other marine resources.

Recently, fatty acid signature analysis (Iverson 1993) has been used to study marine food webs and pinniped diets (Iverson 1995). Fatty acids are the largest constituent of lipids and those of carbon chain length 14 or greater are often deposited in animal tissue with minimal modification from diet. Certain "indicator" fatty acids (Iverson 1993) exist which are particularly useful in food web studies since they can arise only or mostly from the diet. Although methods of fatty acid signature analysis are still being developed, the technique has been used both to identify

general trophic level of diets and to detect major and minor shifts in diet within populations (Iverson, Arnould & Boyd 1997; Smith, Iverson & Bowen 1997). More recently, fatty acid signatures have been used to statistically model the actual diet of pinnipeds (species composition and proportion of diet) (Frost et al. 1999).

The previous harbor seal restoration study (project 064) conducted in PWS during 1994-1999 is one of the two most comprehensive ecosystem studies ever conducted using fatty acids signature analysis (Iverson, Frost & Lowry, 1997; Iverson, Bowen & Ackman, unpublished data), and has come the farthest in advancing the development of this method. In the first five years of study in PWS, fatty acid signatures have indicated that fine-scale structure of foraging distribution of harbor seals can be discerned, and that this is due not only to localized feeding patterns in seals, but also to specific differences in prey species with size and location or habitat within PWS (Iverson, Frost & Lowry, 1997). In addition, major differences in harbor seal diets between the 1970's and 1990's were demonstrated using fatty acid signatures. From this work, it was also possible to infer predominant prey species in the diet of individual seals. Since harbor seals are likely to adjust their foraging patterns to changes in abundance of local prey (Olesiuk 1993; Tollit & Thompson 1996), this suggests that determining diets or changes in diets of harbor seals over time using fatty acid signatures may provide clues not only to changes in foraging patterns, but also to differences in local prey availability, predominant species size classes, and species abundance at the spatial and temporal scales that are essential to the nutrition of individual animals.

Investigations conducted in PWS since 1994 as part of Restoration Study 064 indicate that disease, poor pup production, or emigration are unlikely as causes for the decline. Consequently, the focus of investigations shifted to the question "Is it food?" During 1994-1996 we addressed this question relative to adult and subadult segments of the population, and in 1997-1999 for pups and yearlings.

During 1994-1998, fatty acids signature analysis was conducted on 381 harbor seal blubber samples from PWS, the northern Gulf of Alaska (GOA) and southeast Alaska. An additional 286 samples were analyzed from seals collected in the same areas in the 1970's. These analyses indicate substantial geographic, annual, interdecadal, age, and gender related differences in diversity and species composition of harbor seal diets .

Satellite-tags have provided information about locations, movements, and diving of seals, which has helped us to identify feeding areas and understand feeding behavior (Frost et al. 1996, 1997, 1998). Seventy-one harbor seals have been instrumented with satellite-linked depth recorders (SDRs), including 26 adults, 23 subadults, and 22 pups.

Satellite-tagging data clearly indicate substantial individual variation in the way seals make their livings (Frost and Lowry 1994b; Frost et al. 1995, 1996, 1997, 1998). Some tagged seals used only a few haulouts and made only short trips away from them to feed. Others made longer trips of several days to almost two weeks. Some of these feeding trips were apparently entirely within PWS and others were in the GOA. Analysis of data from newly weaned pups tagged in 1997 and 1998 suggests that their movements are generally similar to those of adults. Contrary to expectations, pups did not appear to move farther or show less site fidelity than adults.

Movements between terrestrial haulouts in central PWS and glaciers in northern and southwestern PWS were made by approximately 20% of the seals tagged since 1991. Most (9 of

13) were by subadults or pups in spring (May-June) and fall (October-November). Icy Bay was used most commonly in spring and Columbia Bay, College Fiord, and Unakwik Inlet in fall. These movements did not result in long-term relocation of the seals. All but one seal that traveled to a glacial haulout subsequently returned to the area where it was tagged. We interpret this to mean that there is not free exchange of seals between glacial ice haulouts and rocky haulouts in other areas of PWS, and that like the seals we have previously tagged, glacier seals may demonstrate considerable site fidelity. If so, this is likely to have a significant impact on the way these seals make a living. Prey are likely different in glacial fiords, water depth is generally deeper, and the seals are not subject to tidal influence which in other areas limits the availability of haulout substrate.

The sample size of satellite-tagged adult, subadult , and pup harbor seals in southern PWS is now sufficient to generally characterize the movements and diving behavior of these age groups of seals. However, we still know almost nothing about harbor seals that use glacial ice for hauling out. Our previous tagging data indicate that most of the seals making trips to the glaciers are subadults and pups. Does this mean that in general most of the seals using these areas are young? Or do "resident" glacier seals represent a normal distrubution of age classes? We know from our own observations and those of hunters that females with pups occur in these areas, but we know nothing about their relative abundance.

Fatty acids analysis in PWS harbor seals and their prey was initially funded by the EVOS Trustee Council starting in 1994 as a pilot project. Early results were published in Marine Ecology Progress Series (Iverson, Frost & Lowry, 1997). In that initial study, fatty acid signatures were used to investigate the diet and spatial scales of foraging in harbor seals and selected prey in PWS and the GOA (Iverson, Frost & Lowry, 1997). Since then, many additional blubber samples and prey have been analyzed. To date, blubber samples collected from 381 harbor seals from PWS, Kodiak Island, and SEAK in the mid to late 1990s have been analyzed for fatty acid composition. In addition, during 1998 we analyzed archived blubber from an additional 286 harbor seals sampled in the 1970s in PWS and the GOA, bringing the total to 667 seals. A total of 1052 potential prey samples representing 22 taxa have also been analyzed for total fat content and fatty acid composition. Classification and regression tree analysis was used to classify seals and prey according to their fatty acid signatures. We continue to find large differences in the fatty acid composition of blubber from seals sampled at Kodiak, SEAK and PWS. Annual differences in diet are evident, as are age and gender-related differences. Diets in the 1970s were found to be substantially more diverse than diets in the 1990s. Additionally, fatty acid signatures distinguished seals from different regions within PWS, as well as from haulout sites only a few kilometers apart. These findings suggested that seals forage very site-specifically.

Prey fatty acid patterns also differed on similarly small spatial scales within PWS. Not only could prey species such as herring and pollock be differentiated from one another using fatty acid signatures, but they could also be distinguished by size-class and location within PWS, reflecting differences in diet with age as well as with fine-scale habitat. Fatty acids analysis indicated that juvenile seals sampled in northern PWS fed only on herring from that region, whereas older seals ate herring from a variety of locations. This may be quite significant for juveniles, since we found forage species to be much higher in fat in northern PWS than elsewhere (Frost et al 1997). It is possible that this northern area, where many of the glacier seals are found, is particularly suitable for the fattening of young harbor seals. The productivity of

another apex predator, the black legged kittiwake, is much higher in northern PWS than it is in the southern sound (Irons et al. 1997).

It is clear that fatty acid signature analysis will be an important contribution to understanding marine food webs in PWS and other marine environments. Perhaps its greatest potential is that it integrates diet over time and allows us to identify, not every individual prey that was eaten, but instead the key prey species that have contributed most to fat reservoirs, and therefore nutritional status (and probably survival) of these seals.

Proposed work in 2000. During the 2000 field season, satellite tagging, sampling, and monitoring will occur in glacial ice areas of PWS. Research will focus on the hypothesis that trophic structure, and therefore the availability of food, is different in glacial areas than it is on southern and central PWS. Particular emphasis will be on pups and subadults, the age groups whose survival is most likely to be impacted by nutritional status. Aerial surveys of a subset of glacial sites will be flown to during the molting period in 2000. Count data from these surveys will be used to develop an overall abundance estimate for seals in glacial ice; develop statistical methods for analysis; and develop an approach to long-term monitoring of harbor seals in PWS that will include both rocky intertidal haulouts and seals on glacier ice. We will attempt to determine how annual changes in counts at glacial sites are related to changes in counts along the normal PWS trend count route. We plan to attach satellite transmitters to 6-8 harbor seal pups and/or subadults in 2000 to investigate movements and habitat use, to assist with the interpretation of dietary information provided by fatty acid analysis, and to identify areas used by newly weaned pups for feeding. Satellite-tagging will also provide information about dispersal of pups after weaning, whether or not they leave PWS, and whether pups born in glacial ice areas show more or less site fidelity than seals in other areas. Body fat content of 20-30 pups and yearlings will be determined using D_2O. Blood, blubber, skin, and measurements will be taken from all seals that are caught during tagging operations regardless of age. Data will be compared to better understand the relationship and nutritional status of seals hauling out in glacial fiords with those from other areas of PWS.

Work proposed in 2001 and 2002. The work being proposed for 2001 be essentially the same as work proposed for 2000. Field work will take place on seals that glacial ice to haul out, and will include aerial surveys, satellite tagging, fatty acid sampling, and D_2O studies. The only significant difference between 2000 and the following year is that aerial surveys in 2001 will also include the standard PWS trend count route A. In 2000, surveys of trend route A will be funded under the final year of Restoration Project 00064. Following the first year of field work on glacier seals, we will evaluate the success of our catching and sampling techniques and modify them as necessary to insure long-term success of the project and maximum utility of data.

ADF&G biometricians who have developed anaytical techniques for PWS harbor seal trend count data collected since 1989 will develop appropriate statistical methods for analyzing count data for ice seals. Different factors likely affect when these seals haul out (for example, they are not subject to tide) and it will be necessary to customize the analysis to this particular group of seals. We also think it is important to continue annual monitoring of harbor seals along Trend Route A for at least a few more years. These surveys are relatively inexpensive to conduct. When trend route A and glacial surveys are conducted at the same time, the only additional cost is for the actual air time. Travel and per diem costs are the same, whether surveys are flown of one or both routes. Although there is some indication that the harbor seal decline in PWS may

be stabilizing, power analysis has clearly demonstrated that 5 years or more would be required to statically document a changing trend. The first indication of an increasing trend was in 1998. Thus, we suggest conducting annual surveys of Trend Route A at least through 2002.

Fatty acid studies will be continued through 2001. Samples of a few select prey species will be analyzed to fill in missing locations or age classes and to enable an examination of annual variability in fatty acid signatures. This will be important for comparisons of diets in glacial and other others. We will analyze blubber samples from seals that we catch each summer, as well as from subsistence caught seals and seals caught by the ADF&G-NOAA harbor seal study. In glacial areas, we will catch, tag, and sample seals. We also plan to catch and sample (but not tag) pups and yearlings from central PWS during several days each year. These seals will allow us to make both annual and geographic comparison between glacier and southcentral PWS seals. Without annual, concurrent samples from non-ice areas it will not be possible to distinguish geographic differences from annual changes in diet.

Work proposed in 2002. The only field work proposed in 2002 will be aerial surveys of trend count A, and possibly of the glacier ice haulout route. No other field work will be conducted in 2002. If the population trend is still not clear by 2002, we will recommend that Trend Route A continue to be surveyed annually. If an increasing trend is evident, we will propose an alternate monitoring schedule, likely every other year. This final year will be used for final data analysis, manuscript publication, and report preparation.

NEED FOR THE PROJECT

A. Statement of Problem

From 1984-1988, harbor seal counts at 25 trend sites in PWS declined by 43% due to unknown causes. The decline continued in 1989, aggravated in oiled areas by the EVOS. Counts of seals at oiled trend count sites declined by 45%, compared to 11% at unoiled sites. More than 300 harbor seals (36% of those in oiled areas) were estimated to have died in PWS due to the spill.

Since 1990, numbers have continued to decline. The rate of decline from 1990-1998 was about 2.4% per year. There were 18% fewer seals in 1998 than in 1990, and 57% fewer than in 1984. The reasons for the decline remain unknown, but may relate to food limitation. It appears that the decline has slowed in recent years and the PWS harbor seal population may, in fact, be starting to stabilize. Future surveys will be required to confirm this.

Despite very good information about the trend of harbor seals in central and eastern PWS, we have little information about seals using glacial ice areas for hauling out. Some glacial haulouts, in PWS have been surveyed in 6 of the last 8 years by ADF&G (Lowry 1991; Loughlin 1992)and Exxon (Burns 1994, 1995 and unpubl.) (Figure 1). Excluding the Columbia Glacier, mean counts vary from 700-1,000 seals, show no statistically significant trend, and are characterized by large annual variations. Attempts have been made to count the Columbia Glacier area where more than a thousand seals may be present, but the seals are difficult to see in the ice, there are too many to count visually, and so far aerial photography has not proved satisfactory. Because glacier seals comprise such a large proportion of the total seals present in PWS, it is important to determine whether surveys of trend route A are also representative of seal numbers and trends in the glacial ice areas.

B. Rationale

Harbor seals are important to residents of PWS for subsistence. In 1985-1989, harbor seals made up 13%-27% of the subsistence foods harvested in Tatitlek and Chenega Bay. During 1992-1995, these two villages harvested less than half the number harvested annually before the spill. Native residents have noted the scarcity of seals and the impact this has had on subsistence hunting. Harbor seals are also watched and photographed by tourists and recreational users of PWS, and they interact with and are incidentally killed by commercial fisheries.

Like all marine mammals, harbor seals have special federal protection under the Marine Mammal Protection Act. Because of the ongoing decline, it is essential that current population data be available so that inappropriate restrictions on human activities are not implemented. National Marine Fihseries Service is currently conducting a Population Viability Analysis (PVA) for harbor seals in Alaska. This analysis will be used to determine whether harbor seals have declined to such a degree that they should be listed as depleted under the MMPA, or threatened/endangered under the Endangered Species Act.

It is important to understand what factors are limiting the harbor seal population in PWS. Recent genetic analysis of microsatellites in DNA suggests that harbor seals in PWS are genetically distinct from harbor seals near Kodiak (Greg O'Corry-Crowe, pers. commun.) We cannot assume, given the ongoing decline, that the number of seals in PWS will return naturally to pre-spill levels. It is necessary to continue monitoring trends, identify and appropriately manage areas of particular biological significance, and communicate information on population status to subsistence hunters and fishermen in order to minimize mortality and augment recovery in any way possible. Commercial fisheries in PWS may face greater restrictions designed to reduce incidental take of harbor seals unless something can be done to understand and reverse the population decline.

The ongoing decline of harbor seals began over two decades ago in the Kodiak area, and was detected at least a decade ago in PWS. Although periodic surveys have documented the downward trends and are useful for determining whether the recovery objective of "stable or increasing population trends" has been met in the trend count area, they are not adequate for determining how the trend count area compares to other parts and other habitats in PWS, what is causing the seal population to decline, or for designing conservation and management measures to facilitate recovery and ensure the future health of the population. Unless research is specifically designed and conducted to investigate the factors limiting harbor seals, it is likely that little progress will be made in understanding and mitigating the decline. This is a difficult but important topic to investigate. It requires a multidisciplinary approach that incorporates an understanding of harbor seal behavior, habitat use, and energetic, with data about the distribution, abundance, and biology of prey species and predators.

C. Location

This project will be conducted in glacial ice areas of PWS, with comparative areas in southcentral PWS. Aerial surveys will be flown of all or a subset of the glacial ice haulouts in northern PWS, depending on recommendations of our staff biometrician who has been analyzing PWS survey data since 1989. Seal tagging and sampling will be conducted in glacial ice areas of northern PWS. Which exact fiord system will be sampled will depend on our ability to catch

seals in a particular area, and the number of seals present during our sampling period. Comparative data will be obtained from a few select rocky intertidal haulouts in central PWS, and by other ADF&G harbor seal studies near Kodiak and in SEAK.

Communities that harvest harbor seals or engage in commercial fishing activities, and may be affected by or utilize results of this study, include Cordova, Chenega Bay, Tatitlek, and Valdez.

COMMUNITY INVOLVEMENT

"Harbor Seal Updates" have been produced by ADF&G harbor seal investigators and distributed to PWS subsistence hunters and other interested persons in PWS communities in previous years, depending on the availability of new and pertinent information. The Principal Investigator participated in the Elder Youth Conference in Cordova during August 1998.

Information from this study will be presented at oil spill symposia, planning workshops, conferences, and in the published literature. Information will be provided to the University of Alaska Sea Grant program and ADF&G Division of Subsistence for use in meetings and discussions with PWS subsistence hunters regarding the biosampling program. ADF&G marine mammals staff regularly attend meetings with various public groups (tourism industry, fisheries, conservation groups, subsistence communities) to inform them about status, important conservation issues, and key research needs for harbor seals.

When invited, investigators will continue to attend meetings of the ANHSC to discuss study results and proposed research. Investigators will assist as requested in developing community-based sampling programs. Biosampling is a cooperative effort of the ANHSC, NMFS, the University of Alaska Sea Grant program, and the ADF&G Division of Subsistence. Personnel from this harbor seal project will facilitate sample analysis and communication of results to community residents.

PROJECT DESIGN

A. Objectives

1. MONITORING

1-1. Monitor the abundance and trends of harbor seals at 25 sites along trend count route A in PWS to determine whether the PWS harbor seal population has declined, stabilized, or increased since the EVOS.

1-2. Monitor the condition of pups and yearlings in southcentral PWS (D_2O equilibrations) to provide a basis for understanding population trend and responses to changing environmental conditions.

1-3. Monitor annual changes in diet of seals in southccentral PWS by using fatty acid signature anlaysis.

1-4. Provide information to subsistence hunters so they can make informed decisions about the appropriate level of harvest for harbor seals.

2. GLACIER SEAL STUDY

2-1. Monitor the abundance and trends of harbor seals at glacial ice haulouts in northern in PWS (Harriman Fjord, College Fjord, Unakwik Inlet, Columbia Bay) to determine whether counts along trend route A adequately reflect population trends in other areas of PWS.

2-2. Identify important prey species in the diets of harbor seals from glacial ice areas of PWS, with a particular emphasis on pups and yearlings, and determine whether there are dietary differences among different components of the population as well as between seals hauling out on ice and seals using rocky intertidal haulouts in central and southern PWS.

2-3. Measure the condition of pups and yearlings from glacial ice habitats (D_2O equilibrations) to determine whether pups and yearlings using glacier ice habitats are larger and fatter than those in southcentral PWS.

2-4. Determine foraging range and diving behavior of harbor seal pups and juveniles tagged in areas of glacial ice, and compare to similar information from seals tagged on rocky intertidal haulouts in southern and central PWS.

B. Methods

These hypotheses were developed to meet the above objectives during FY 00 – FY 02:

MONITORING

Hypothesis 1: The PWS harbor seal population has stabilized and/or increased since the EVOS.

1. Conduct aerial surveys along PWS trend route A during molting in 2000 - 2002;
2. Analyze survey data using the most appropriate statistical models (as recommended by project 064) and develop estimates of the annual number of observed seals.
3. Relate observed seal count to a number of covariates, including location, calendar day, time, height of low tide, time of low tide, qualitative assessments of wind and sky conditions, and trends for each site.
4. Evaluate survey data collected since 1989 to determine whether seal numbers are continuing to decline, have stabilized, or are recovering to pre-spill levels.

Hypothesis 2: Annual differences in diet and condition of harbor seal pups and yearlings can be used to predict population trends as determined by aerial surveys.

1. Obtain blood and blubber samples from pup, yearling and other subadult harbor seals from sites in southern and central PWS for which there is historical data.
2. Analyze blubber samples for fatty acid signatures of individuals and age groups.
3. Identify and quantify annual differences in diets of young harbor seals.
4. Use D_2O analyses to determine annual variability in fat content of young seals.
5. Examine annual changes in diet and condition in light of abundance trends as determined by aerial surveys during the molting period.

GLACIER SEAL STUDY

Hypothesis 3: The population trend of harbor seals hauling out on glacial ice in northern PWS is the same as the trend found along trend route A.

1. Conduct aerial surveys of haulout areas during molting in 2001 - 2002;
2. Analyze survey data using the most appropriate statistical models and develop estimates of the annual number of observed seals.
3. Relate observed seal count to a number of covariates, including location, calendar day, time, height of low tide, time of low tide, and qualitative assessments of wind and sky conditions.
4. Evaluate variability and trend information from glacial haulout sites to determine whether they show the same trends as seals on trend route A, and whether there is more or less variability and therefore statistical precision).

Hypothesis 4: The diets of harbor seals using glacial fiords and bays of PWS differ from diets of harbor seals in southern and central PWS, and reflect differences in the distribution, abundance, and fat content of important forage fishes at relevant scales.

1. Obtain blood and blubber samples from pup, yearling and other subadult harbor seals in glacier ice areas and at rocky haulouts in southern and central PWS (same as 2-1).
2. Analyze blubber samples for fatty acid signatures of individuals and age groups.
3. Determine whether diets of harbor seals (particularly young animals) differ between glacial ice areas and southern and central PWS.
5. Assess variation in the fat content and fatty acid composition of prey species that are likely to be of importance to harbor seals in glacial fiord and other regions of PWS.
6. Using mathematical models, estimate the diet of the differing demographic groups among the differing regions and determine whether juveniles appear to be less constrained by prey availability in glacial ice areas of northern PWS than elsewhere.

Hypothesis 5: Juvenile harbor seals are particularly sensitive to characteristics of prey abundance such as depth, prey size, and prey type. Prey are more available to young harbor seals in glacial fiords of northern PWS and are higher in fat then elsewhere in PWS, resulting in larger and fatter pup and yearling seals in glacial areas.

1. Obtain blood and blubber samples from pups, subadult and adult harbor seals in glacial and other regions of PWS during late June/early July, representing the diets of pups about 2 weeks post-weaning (and therefore of their mothers) and the first over-winter diets for yearling harbor seals.
2. Analyze blubber samples for fatty acid signatures of individuals and age groups.
3. Measure total body composition (fat, protein, and lean body mass) of pups and juveniles using D_20 equilibration as an indicator of individual nutritional status.
4. Use fatty acids signature analysis to determine whether individual, age-related, and interannual differences in diets occur in harbor seals from these two different habitats.
5. Continue to assess variation in the fat content and fatty acid composition of prey species in PWS, but with a particular emphasis on characterizing prey in glacial fiords and size-class and regional differences in the four prey species that are likely of most importance to harbor seals and especially juveniles: herring (*Clupea pallasi*), pollock (*Theragra chalcogramma*), capelin (*Mallotus villosus*), and sandlance (*Ammodytes hexapterus*).
6. Develop mathematical models and associated software programs to quantitatively estimate species and size-class composition of diets for seals in glacial and non-glacial areas.
7. Estimate the most important prey items (and size classes) in diets of different demographic groups of harbor seals and determine whether diets of pups and small subadults, and of large subadults and adults in glacial ice areas differ significantly from

diets of similar age groups in southern and central PWS. Relate this to data obtained from satellite-tagged seals on characteristics diving behavior.

Hypothesis 6. Harbor seal pups and juveniles spend more of their time foraging to obtain adequate nutrition than do adults; pups in central and southern PWS spend more time foraging than pups in glacial areas of PWS.

1. Compare dive data from seal pups satellite tagged in glacier areas of PWS with data from seal pups tagged in central and southern PWS.
2. Assess the annual variability in the foraging behavior of satellite-tagged seal pups.

The final year of field study with take place in 2001, with final data analysis and reporting to take place in 2002. In particular, we expect to prepare reports and manuscripts on the subjects of: 1) movements of satellite-tagged harbor seal pups in glacial areas of PWS; 2) comparison of diving behavior of harbor seal pups in glacial fiords and other areas of PWS; 3) differences in diet and condition of pups and yearlings between glacial fiords and other areas of PWS; 4) a comparison and evaluation of surveys conducted along tend count A and glacial haulouts in PWS.

Aerial Surveys and Analysis (2000 - 2002)

Harbor seal abundance will be monitored by flying aerial surveys during the molting period in mid to late August. A fixed-wing aircraft will be used to survey 25 trend count sites along Trend Route A at an altitude of 700-1000 ft. These haulout sites have been used by ADF&G for PWS harbor seal trend counts since 1983, including NRDA and Restoration studies in 1989-1999 (Calkins and Pitcher 1984; Pitcher 1986, 1989; Frost and Lowry 1994a; Frost et al. 1994a; Frost et. al 1995; Frost et. al 1996). The trend count route includes 7 sites that were impacted by the EVOS (Agnes, Storey, Little Smith, Big Smith, Seal, and Green islands, and Applegate Rocks) and 18 unoiled sites, as well as several new sites that have been surveyed since 1997. The survey methodology and observers will be the same as those used in PWS harbor seal studies conducted in 1989-1998 (Frost et. al. 1996, 1997, 1998), and as summarized below.

In addition, we plan to develop survey methods for seals hauled out on glacial ice in northern PWS. We plan, at this point, to monitor Unakwik Inlet, College Fjord, Columbia Bay, and Harriman Fjord. Currently, there is no reliable or confirmed aerial method for surveying large numbers of seals that are widely dispersed on glacial ice (Mathews and Womble 1997). Some areas can be counted visually (with unknown accuracy) or photographed for later counting, depending on how many there are, how dirty the ice is, and their distribution within the ice. However, when many hundreds of seals are distributed over broad areas of dirty ice (such as the Columbia Glacier) it is not possible to make accurate counts using conventional methods. For example, Burns (1994, 1995 and unpubl. data) reported actual counts of seals in College Fjord, Harriman Fjord, and Unakwik Inlet where total numbers were less than 500 or 600 seals, but was only able to estimate numbers in Columbia Bay where seals were widely spread throughout the ice and numbered more than 1,000. During August 1999, ADF&G will conduct a pilot study to count seals on glacial ice in PWS using aerial cameras linked to the survey aircraft's Global Positioning System. This method will provide automatic control of overlap and avoid duplication of counts, one of the biggest problems with all but the most sophisticated aerial photography (these techniques are seldom available for routine wildlife surveys). The computer software necessary to accomplish this type of photogrametric surveys has already been developed by ADF&G for use in other large-mammal surveys. If the pilot study undertaken in

1999 is successful, we will use the same methods for surveys of seals on glacial ice in 2001 and perhaps beyond. Results of satellite tagging of glacier seals, as well as the pilot photogrametric survey will be analyzed before a final decision is made about the utility of glacial surveys.

Catching and Sampling Seals (2000-2001)

Seals will be caught by entanglement in floating light-weight nets placed near seals hauled out on glacial ice. Until the last two years, no methods had been worked out for catching harbor seals in ice. Recently, however, investigators from ADF&G and NMFS have been successful in catching seals in the ice, and we will be able to use techniques developed by the.

When seals become entangled, they will be brought into the boats, disentangled from the net, and placed into hoop nets (large stockings made of 1 cm mesh soft nylon webbing). As necessary, seals will be sedated with a mixture of ketamine and diazepam administered intramuscularly at standard doses (Geraci et al. 1981). Each seal will be weighed, measured, and tagged in both hindflippers with individually numbered plastic tags. Field personnel will collect approximately 50 cc of blood from the extradural intervertebral vein. Standard virology screens (phocine distemper virus, herpes, and others as indicated) will be run on these samples. A 0.5 cm x 2.5 cm blubber biopsy for fatty acid analysis and a small piece of skin for genetics studies will be taken form each seal. Virology screens will be coordinated and paid for by the ADF&G's NOAA-funded harbor seal study, as will all genetics analyses. Seal pups and small juveniles will be selected for instrumentation with satellite tags, as described below.

Total body composition (fat content, protein content, lean body mass) will be measured on a subset of the pups and juveniles that we sample using isotope dilution with deuterium oxide (D_20). D_20 is a stable isotope of water, which is widely used as a non-invasive method to measure body water pool size and the rate of water turnover in mammals and other vertebrates (Nagy & Costa 1980; Oftedal & Iverson 1987; Oftedal, Iverson & Boness 1987; Iverson et al. 1993). After administration of a known amount of D_2O, the isotope completely equilibrates with all body water of the animal. Measurement of the final dilution of D_2O in the body water (dilution space) can then be used to accurately measure total body water content (Oftedal, Bowen & Boness 1993). Body water content is then used to calculate total body fat, protein, and energy stores of the seal, based on the fact that the water and protein contents of lean body mass (fat-free mass) are approximately constant among mammals, particularly among individuals of a given species and age (Pace & Rathbun 1945; Reilly & Fedak 1990; Iverson et al. 1993).

Prior to the onset of the D_20 procedure, seals will be weighed to the nearest 0.5 kg, and a blood sample. Any stomach contents of the animal will be evacuated by gastric intubation using a 3/8 inch veterinary stomach tube. A pre-weighed amount (approximately 1g/kg body mass) of deuterium oxide (99.9% purity), contained in a syringe with a three-way stopcock, will be delivered by gastric intubation using a small 12 French stomach tube (to reduce total surface area during delivery). The syringe and stomach tube will then be rinsed with 2 x 5 ml quantities of water, and air blown through the tube as it is withdrawn to ensure complete delivery. The animal will then be held for approximately two hours to permit isotope equilibration. After that, two sequential blood samples, separated by about 20 minutes, will be taken to ensure that equilibration has occurred. Bloods will be centrifuged and sera collected and frozen in airtight cryovials until the time of analysis. Laboratory analyses will be done at Dalhousie University. Total free water will be collected from blood sera by heat distillation, and D_2O concentration will be determined by quantitative infrared spectrophotometry according to Oftedal & Iverson (1987)

and Oftedal, Iverson & Boness (1987) on a Perkin Elmer Fourier Transfor Infrared Spectrophotometer with integrated data station (Paragon 1000).

Seals will be caught in two regions of PWS: 1) glacial ice areas in northern PWS, and 2) near rocky haulouts in southcentral PWS, to coincide with sampling areas used is previous years . We will try to catch and sample approximately 40-60 seals total per year distributed between the two habitat types.

Fatty Acids Analysis (analysis 2000-2001)

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

The use of specific lipids as biological markers has been demonstrated in a number of studies on fish and copepods (Lee, Nevenzel & Paffenhofer 1971; Sargent et al. 1988; Fraser et al. 1989; Klungsoyr et al. 1989; Graeve, Kattner & Hagen 1994; St. John & Lund 1996). Relative proportions of dietary fatty acids have also been shown to be reflected in the fatty acid composition of storage lipids in both captive and free-ranging carnivores (e.g., Reidinger et al. 1985; Rouvinen & Kiiskinen 1989; Colby, Mattacks & Pond 1993; Pond et al. 1995). In seals, ingested fatty acids can be deposited directly into adipose tissue, such that blubber may be a mirror of current diet when a seal is rapidly fattening on a high fat diet (Iverson et al. 1995), or may reflect a longer-term integration of dietary fatty acids and possibly biosynthesized fatty acids at times of reduced intake (Kirsch, Iverson & Bowen 1995).

This concept of fatty acids as trophodynamic indicators can be applied to harbor seals. In general, lipid transfer from prey to deposition in tissue is extremely efficient (Iverson 1988, Iverson et al. 1995). Because certain fatty acids cannot be biosynthesized by seals, these can be identified as being of dietary origin. Since most seals undergo seasonal periods of fasting and depletion of fat stores (e.g., during the breeding season or the molt) followed by intensive blubber deposition (prior to the subsequent breeding season), blubber fatty acids usually reflect the integration of diet over a period of several months. Thus, fatty acids in blubber provide information on dietary history of the animal. Since many seals tend to feed on only a single or few selected prey species at a given time or season (e.g., Bowen 1990), this facilitates the use of fatty acid signatures.

In the initial study funded by the EVOS Trustee Council, we used fatty acid signatures to investigate the diet and spatial scales of foraging in harbor seals and selected prey in PWS and the Gulf of Alaska (Iverson, Frost and Lowry, in press). We found large differences in the fatty acid composition of blubber from seals sampled in geographic regions several hundred

kilometers apart. Within PWS, fatty acid signatures distinguished seals from haulouts only a few kilometers apart, suggesting that seals forage very site-specifically. Prey fatty acid patterns also differed on similarly small spatial scales within PWS.

More recently, fatty acid signature analysis is being used to quantitatively estimate the composition of seal diets. This means not only determining the species composition, but also the size classes of species eaten and possible area from which the prey were fed upon. This approach will be used to document annual and habitat-related (glacial ice areas, non-glacial areas) differences in diet. Juveniles in particular are thought to be significantly affected by reduced prey availability at scales relevant to the nutrition of individuals (NRC 1996). Thus, there could be several indications about stresses on juveniles through understanding diets in different habitats. Small forage fish species such as capelin and sandlance have long been an important part of pinniped diets and a decline in these prey species may have affected the seal populations which depend upon them. Some areas, such as glacial fjords, may have alternate, easily catchable prey such as shrimp (Dr. Ted Cooney, pers. commun.) which serve to mitigate the impact of reductions in other forage species.

Blubber samples will be taken from seals of the various demographic groups using routine biopsies (sterile 6 mm biopsy punches). Samples will be collected in late June-early July to coincide with initial summer foraging period. Samples will be placed in chloroform and methanol with BHT as an antioxidant, and kept frozen until analyzed. Samples will be collected from all seals that are caught during tagging operations. Blood will be collected from the same animals and centrifuged in the field. In addition, some samples may be available through the biosampling program being conducted by the Alaska Native Harbor Seal Commission.

Through project 064, potential harbor seal prey in PWS have been extensively sampled. The existing "prey library" includes more than 22 taxa and 1,000 individual prey. Few additional prey items will be collected as part of this study. We will focus on several key prey species which are readily available from several locations without large-scale fish sampling programs. We plan to continue to assess annual variation in the fat content and fatty acid composition of prey species. Particular emphasis will be on characterizing size-class and regional differences in the four prey species that are likely of most importance to harbor seals and especially juveniles: herring, pollock, capelin, and sandlance. We will also attempt to collect and analyze any prey thought to be unique to the glacial fjords.

Laboratory analysis and evaluation of data will be conducted by Dr. Sara Iverson at Dalhousie University, Nova Scotia. Fatty acids will be extracted from seal blubber and prey according to methods described in Iverson (1988). Fatty acid methyl esters will be prepared directly from aliquots of the chloroform extract, then extracted and purified in hexane. Analysis of fatty acid methyl esters will be performed according to Iverson et al. (1992) using temperature programmed capillary gas liquid chromatography and linked to a computerized integration system (Turbochrom, PE Nelson). Identifications of rare isomers will be performed using techniques described in Iverson, Frost and Lowry (in press). Approximately 70 fatty acids and isomers can be separated and quantified in most marine lipids. The proper isolation of all components in any sample is critical in assessing diets and prey items; these methods are currently set up and routinely used in the Dalhousie University laboratory of Dr. Iverson.

Data will initially be analyzed using a multivariate model called classification and regression tree (CART) analysis (Clark and Pregibon 1992). This model has recently been applied and modified

for fatty acid signature analysis (Iverson et al. 1997; Smith et al. 1997). CART is a non-parametric technique which considers all 70 component fatty acids in each sample and uses the fatty acid arrays of species to determine classification rules for types of signatures. CART proceeds by recursively partitioning data into two or more groups based upon a series of dichotomous splits, hence building complex trees through which observations (predators or prey) may subsequently be sent for classification. This method will allow us to differentiate individual seals and groups of seals by such factors as age-group, pregnancy status, or haulout location. These differences in turn are a function of differing fatty acid signatures resulting from differences in diets. We will also use CART to determine characteristics and differences among prey by species and within species by size class, time period, and geographical location. We will also account for differences in fatty acid classes in the use of CART. In other words, in the analysis and interpretation of data, fatty acids will be grouped as: 1) components which could readily be biosynthesized by the seal; 2) components that could be biosynthesized but at the measured levels are likely mostly of dietary origin; and 3) components that could only come from the diet. Categories 2 and 3 represent the important "indicator" fatty acids (Iverson 1993). The latter two categories will be most heavily relied upon in interpreting CART results.

Modeling of Seal Diet Composition using Fatty acid Signatures (2000-2002)

The use of fatty acids to elucidate diet and trophic relationships has proceeded considerably in its developmental stages and now requires a mathematical modeling component in order to use it quantitatively. Using fatty acids to determine the diet of seals is facilitated by the fact that seals go through biannual periods of extensive blubber fat depletion followed by intensive fattening and that 2-4 prey species often account for most of the diet. Nevertheless, in free-ranging seals, fatty acid composition of lipid stores will rarely, if ever, match that of their prey because dietary fatty acids will be integrated into the seal's fatty acid signature. The time course of these changes will depend on the rate of food intake and the extent to which lipids are stored seasonally. Finally, biosynthesis of some fatty acids will take place, thus altering their representation in the signature. Thus, the next stage in using fatty acids to estimate diet composition, must be the development of a statistical model which takes possible prey species signatures and computes the most-likely mixture of signatures (species and levels) to create the closest signature (a maximum-likelihood estimate) to that of the predator. Such a statistical program must incorporate information on a wide range of potential prey signatures, and the variability in these signatures with size-class and geographical location, as well as season if applicable. The mathematical model must also incorporate a relative weighting of prey signatures that reflects the proximate fat content of each prey and size class, and finally, weighting on individual fatty acids as a function of their ability to be biosynthesized by the predator. We expect to start out from a basis of an optimization problem with a simple least square error assumption (R. Myers, pers. comm.). Given the constraints listed above, standard optimization methods cannot be used. The inequality (of fatty acids) is more difficult to deal with analytically and hence also the estimation of standard errors. However, software can be written and developed to handle these. This work will be done in the laboratory of Dr. S. Iverson as a cooperative effort between Alaska and Scotian Shelf research and with partial support from NSERC.

Fatty acid signature analysis has not to date been a stand-alone method, but neither has any other currently available method for examining marine mammal diets. Stomach contents analysis is limited by our ability to obtain large enough samples, the digestive state of contents, and by the fact that food in a stomach represents a single meal. In PWS, large tidal fluctuations every 6 hours make it virtually impossible to collect scats from areas where seals haul out. Stable

isotopes indicate the trophic level at which seals feed and temporal variations in prey type, but provide little information on specific prey. Studies of prey availability (e.g. from trawl surveys) are necessary to establish the "menu" from which seals may choose, but they do not reflect the availability of prey to seals on relevant scales or the energetic costs of capturing different prey. Progress towards answering the question of "Is food limiting harbor seals?" will most likely come through the combination and integration of a variety of approaches, but it is clear from our previous work that fatty acids may be a particularly valuable tool in achieving a better understanding of trophic dynamics, dietary differences and demography of harbor seal populations in PWS and the Gulf of Alaska.

Satellite-tagging (2000-2001)

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

Restoration study 064 has demonstrated that SDRs are an effective means of monitoring the movements and haulout locations of harbor seals in PWS. During 1992-1998, significant data were received from SDRs attached to 71 harbor seals in PWS, including 30 males and 41 females. Twenty-six were adults, 23 were subadults, and 22 were pups. SDRs were attached to 28 seals from areas in central PWS that were oiled by the EVOS (Seal Island, Herring Bay, Bay of Isles, Applegate Rocks); four from eastern PWS (Olsen Bay, Gravina Island); one from northwestern PWS (the Dutch Group); and 38 from unoiled sites in southcentral PWS (Port Chalmers, Stockdale Harbor, Little Green Island, and Channel Island). SDRs were operational for up to 10 months, and provided locations for about 80% of those days.

During 2000-2001, SDRs will be attached to 6-8 harbor seal pups and/or yearlings each year in glacial ice areas. These will include College Fjord, Unakwik Inlet, Harriman Fjord, and Columbia Bay. Actual tagging locations will depend on where seals are present and can be caught. One-quarter-watt transmitters (10 cm x 5 cm x 3 cm and weighing 170 g) will be attached to the mid-dorsal surface of seal pups by gluing with epoxy resin (Fedak et al. 1984; Stewart et al. 1989). SDRs attached after weaning should remain attached until the next molt, and may operate as long as 10 or 11 months. We may consider using location-only SDRs for some pups. The cost is approximately half the cost for tags that also provide dive information.

Data will be acquired from the ARGOS satellite receiving system and formatted using software provided by the manufacturer of the transmitters. Each SDR will transmit signals to polar-orbiting satellites whenever the seal is hauled out or when it surfaces sufficiently long for a transmission to occur. An uplink occurs when a satellite is positioned to receive the signal. Information transmitted by the SDR is used by Service ARGOS to calculate the geographic location of the seal. Units will be equipped with built-in programmable microprocessors to collect and summarize data for periods when animals are diving and store it for later transmission, as has been done for crabeater seals, Steller sea lions, and spotted seals (Hill et al.

1987; R. Merrick, personal communication; Lowry et al. 1994a). These data will be stored in six hour blocks and transmitted to the satellite once the six hour data collection period is complete. Sensor information from a pressure transducer and a conductivity switch will be used to indicate when the animal is hauled out. Data from four periods will be stored in memory, providing at least a 24 hour window for transmission before the data are lost. Dive data will be summarized as histograms in depth bins of 4-20 m, 21-50 m, 51-100 m, 101-150 m, 151-200 m, 201-250 m, 251-300 m, 301-350 m, and over 350 m, and duration bins of 0-120 seconds, 121-240 seconds, 241-360 seconds, 361-480 seconds, 481-600 seconds, 601-720 seconds, 721-840 seconds, 841-960 seconds, 961-1080 seconds, and over 1080 seconds. In addition, SDRs will store and transmit the amount of time spent in each depth bin and the total time spent at the surface.

Each SDR broadcasts a unique identification code so that data can be assigned to a particular seal. Position accuracy for all geographical location information is rated by Service ARGOS to reflect the predicted accuracy of the calculated locations (Fancy et al. 1988, Stewart et al. 1989). Locations calculated by ARGOS will be screened for accuracy and plotted on charts of PWS.

Data on the haulout patterns of tagged seal pups will be examined for indications of daily or seasonal variations, for example to determine whether there is a change in the frequency of haulout by season, or whether the amount of time spent hauled out changes. Plots of locations where continuous signals are received will be used to determine the degree and regularity of use of particular haulout sites. We expect to receive fewer locations of seals while at sea, because the transmitter antenna will frequently be submerged. At-sea locations will be plotted as an indication of areas used for feeding. Information on depth and pattern of diving will be compiled, and will provide additional information on the general areas used for feeding.

Dive data will be presented as graphs and histograms which indicate the range in individual behavior as well as summary data for all seals combined. Dive data histograms will present the number of dives at different depth increments and by duration of dive. Means and standard deviations for dive depth and duration will be calculated and compared for seals in different locations or habitats and at different times of day and year. Compilation of data on time and location of feeding dives will be used to identify feeding areas near different haulouts, if possible. If sensors indicating whether the seal is on land or at sea become more reliable and the necessary SDR software is developed to provide a continuous record of this information, then diving and hauling out cycles will be examined relative to time of day, tide, and season. These data will be compared for different age groups. Summaries of the number and quality of uplink data and at-sea position data will be presented in tabular form.

Tabular summaries will also be prepared for use of different haulouts by individual seal pups, and frequency of haulout and amount of time spent feeding by season. These data will be used to evaluate site fidelity of seal pups, to quantify the amount of interchange among haulouts within and outside of glacial fjords, to determine seasonal importance of particular haulouts, to identify areas used for feeding, and to examine differences in movements and feeding behavior of pups tagged near glaciers and in southern and central PWS.

C. Contracts and Other Agency Assistance

Survey aircraft will be chartered from the private sector. Charter aircraft for surveys will not require contracts. ADF&G maintains a list of qualified air charter operators. Aircraft for surveys will be chosen from this list according to state procedures. Vessels will also be chartered

from the private sector. Vessel support for tagging work will use small vessels contracts that will be completed by the Principal Investigator according the state SOP manual.

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

Satellite SDRs will be purchased under contract award from Wildlife Computers, a private company in Seattle, Washington. The contract award is valid through the proposal period. Wildlife Computers is the only company in the United States which manufacturers SDRs with the capabilities necessary to acquire the data we require about diving behavior of seals.

Fatty acids and D_2Oanalyses and interpretation will be done by Dr. Sara Iverson at Dalhousie University through a Cooperative Agreement between ADF&G and Dalhousie. Dr. Iverson is the only person in North America with specific experience in analysis of fatty acids in seal blubber, and particularly with the sophisticated statistical analyses necessary to infer diet from the relative abundance of these fatty acids.

SCHEDULE

A. Measurable Project Tasks for FY 00 (October 1, 1990 - September 30, 2000)

FY 00: October 1, 1999- September 30, 2000

October-December:	(Data analysis, manuscript preparation for Project 00064)
January (3-4 days)	Attend Annual Restoration Workshop (funded by Project 00064)
January:	Order SDRs for 2000 field work, arrange Service Argos contracts
January-March:	Arrange logistics (vessel, plane, contracts, equipment)
January-March:	Research techniques for catching glacier ice seals
February (2-3 days)	Coordination meeting for ADF&G and NOAA harbor seal studies
April 15:	Annual progress report (suggest part of 00064 since no field work will be accomplished to date)
April 15:	Submit renewal proposal
June 20-July 7 (~12 days):	Sample seals in glacier ice areas of PWS and in central PWS
August 15-30:	Aerial surveys in PWS during molting (Trend A covered by 00064 in FY 2000, no glacier surveys this year)
August-September:	Retrieve Argos SDR data
September:	Analyze aerial survey data
September:	Begin fatty acid and D_2O analysis and interpretation

FY 01: October 1, 2000- September 30, 2001

October-December:	Aerial survey data analysis, trend route A
October – March:	Analysis of fatty acid and D_2O data
October – June	Retrieve and analyze Argos SDR data from seals tagged in glacier ice areas
January (3-4 days)	Attend Annual Restoration Workshop
January:	Order SDRs for summer tagging, arrange Service Argos contracts

January-March:	Arrange logistics (vessel, plane, contracts, equipment)
January-March:	Research techniques for catching glacier ice seals
February (2-3 days)	Coordination meeting for ADF&G and NOAA harbor seal studies
April 15:	Annual progress report
April 15:	Submit renewal proposal
June 20-July 7 (~12 days):	Sample seals in glacier ice areas of PWS and in comparative study area in central PWS
August 15-30:	Aerial surveys in PWS during molting – glacier ice haulouts and Trend A

FY 02: October 1, 2001- September 30, 2002

October-December:	Aerial survey data analysis, trend route A
October – March:	Analysis of fatty acid and D_2O data
October – June	Retrieve and analyze Argos SDR data from seals tagged in glacier ice areas
January (3-4 days)	Attend Annual Restoration Workshop
April 15:	Annual progress report
August 15-30:	Aerial surveys in PWS during molting – glacier ice haulouts and Trend A
September 30:	Submit final report and draft manuscripts

B. Project Milestones and Endpoints

MONITORING

Objective 1-1 (Monitoring trend route A)

April 2001-2002:	Submit annual reports describing PWS harbor seal trend A analysis
August 15-30, 2001-2002:	Conduct aerial surveys at trend A sites in PWS
September 30, 2002:	Submit final report with recommended monitoring scheme

Objective 1-2, 1-3: (Monitoring condition and diet)

June-July, 2000-2001:	Sample 20-30 seals/yr in southcentral PWS for blubber fatty acids
June- July, 2000-2001:	Sample 20-30 seal pups and juveniles/yr using D_20 for body composition (southcentral PWS)
October-March, 2000-2002:	Analyze blubber samples for fatty acids and blood for D_20
November 2001:	Paperson fatty acids work at 14th, 15th Marine Mammal Conf.
September 2002:	Submit manuscript describing analysis of diet and body composition relative to observed trend based on aerial surveys

Objective 1-4: (Information to hunters)

November? 1999-2001:	Attend ANHSC meetings to discuss status and studies with hunters, or provide input to staff as requested

GLACIER SEAL STUDY

Objective 2-1 (Monitor abundance on glacial ice haulouts in northern PWS)

April 2002:	Submit annual report describing glacier haulout analysis and comparing trends here and on trend route A
August 15-30, 2001-2002:	Conduct aerial surveys at glacier sites in PWS
December, 2002:	Submit manuscript on comparison of trend A and glacier ice hauouts, methods for surveying glacier haulouts

Objectives 2-2, 2-3 (Diet and condition of glacier seals)

June-July, 2000-2001:	Sample 30-50 seals (glaciers and other)/yr for blubber fatty acids
June- July, 2000-2001:	Sample 30-40 seal pups and juveniles/yr using D_20 for body composition (glacier and other)
October-March, 2000-2002:	Analyze 50-80 harbor seal samples/yr for fatty acids; analyze D_20 samples
November 2001:	Paper on fatty acids work at 14th, 15th Marine Mammal Conf.
September 2002:	Submit manuscript describing comparative diet work – glacier seals and other

Objective 2-4 (Foraging range and diving of glacier seals)

June-July 2000-2001:	Attach SDRs to 6-8 seal pups in glacier areas of northern PWS
Ongoing:	Retrieve and analyze SDR data
November 2001:	Paper at 14th, 15th Marine Mammal Conf. on PWS seal diving
September 2002:	Submit manuscript on diving, movements of glacier pups in PWS

C. Completion Date

This project will include 3 fiscal years, FY 00 – FY 02. Field work and laboratory analyses will be conducted during FY 00 – FY 01. Aerial surveys, final data analyses will be conducted and a final report prepared in FY 03.

PUBLICATIONS AND REPORTS IN FY

1. Oral/poster presentations at 14th Biennial Conference on the Biology of Marine Mammals; papers to include harbor seal diving behavior, fatty acids analysis, and trend count analysis (November 2001)
2. Oral/poster presentations at EVOS Restoration Annual Workshop (January 2001-2002)
3. Submit manuscript on PWS glacier seal movements and diving (September 2002)
4. Annual report for each FY studies; will include results and/or draft manuscripts of molting surveys including trend analyses; analysis of data for SDRs deployed on pups; status report on fatty acid and D_2Oanalyses (April 2001 - 2002)
5. Manuscript describing fatty acids work (September 2002)
7. Report of field activities for July pup tagging and August surveys (September 2000-2001)
8. Final report for project (September 2002)

Manuscript titles and journals to which they will be submitted have not been determined. Topics include: 1) habitat related (glacier and non-glacier) differences in harbor seal diets in Prince William Sound using fatty acid signature analysis (Iverson, Frost, et al); and 2) seasonal movements and distribution of satellite-tagged seals in glacier areas of PWS (Lowry and Frost). It is possible that additional manuscripts will be prepared described.

PROFESSIONAL CONFERENCES

Project investigators plan to attend the 14th Biennial Conference on the Biology of Marine Mammals in November 2001. This biennial conference is sponsored by the Society for Marine

Mammalogy and is the largest marine mammals conference in the world. Abstracts will be submitted and it is anticipated that oral or poster presentations will describe the results of fatty acids (Iverson), satellite-tagging studies (Frost or Lowry), and statistical analysis of surveys (Ver Hoef). Results of other studies using samples from PWS provided by this restoration study are also likely to be reported but travel will not be funded by this grant.

NORMAL AGENCY MANAGEMENT

This project is funded entirely by the Trustee Council as a restoration project. ADF&G conducts no other studies of harbor seals in PWS that are not a part of the restoration program. ADF&G has no management responsibility for harbor seals. ADF&G biologists are conducting this research as principal investigators because of their many years of experience investigating the biology of seals and other marine mammals in Alaska.

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

Without this project, information on the status and trend of harbor seals in PWS will not be regularly available. There will be no systematic documentation of trend, and whether or not the decline continues will be unknown for a much longer time than if regular monitoring continues. Power analysis of data collected through this study has indicated that a minimum of five consecutive surveys is required to reliably detect a trend. If surveys do not occur on a regular basis, it will be a very long time before a trend can be correctly identified. At present, questions have been raised by the public and other scientists about whether the trends and movements/feeding behavior of harbor seals on rocky haulouts also reflect trends and behavior of seals in areas of glacial ice. Since at least half and perhaps more of the seals in PWS reside in these glacial ice areas, it is important to address this issue.

Because of Trustee Council-funded projects, progress is being made on communicating information about the decline to the public, in particular to fishermen who may incidentally take harbor seals while fishing and to subsistence hunters from PWS villages. This transfer of information is making local residents more aware of the factors that may affect the decline, and has resulted in the initiation of a village-based biosampling program that may provide important samples to researchers. One of the significant long-term benefits of this and other harbor seal studies will be the involvement of local hunters in the research and management of harbor seals and the formation of the Alaska Native Harbor Seal Commission.

The statistical methods developed to analyze survey data from PWS will be applicable to harbor seal surveys in other regions of Alaska and elsewhere. Other investigators should be able to design more reliable and cost-effective surveys using methodology developed through this Trustee Council-funded project. Specifically, the issue of comparability of trends at glacial and other haulouts is of great concern in many other parts of the state, too. It is imporatnt to conduct

investigations that will allow us to quantitatively compare trends in nearby glacial and non-glacial sites. The application of fatty acids analysis to investigations of diet and changes in diet is likely to have significant and far-reaching effects on our ability to investigate the trophic dependencies and interactions of many other species, not only marine mammals. Already, techniques developed as part of this project appear to have application for studies of fish movements and stock identity.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Other EVOS-funded marine mammal studies have included: Recovery of Harbor Seals from EVOS: Condition and Health Status (Project 001); Harbor Seals and EVOS: Blubber and Lipids as Indices of Food Limitation (Project 117-BAA, UAF); and Isotope Tracers - Food Web Dependencies in PWS (Project 170, UAF). Investigators from the three projects regularly communicate and discuss these projects, and will continue to do so in the future.

This newly proposed project is a follow-up to project 00064 and will be a multidisciplinary, inter-agency undertaking. Surveys and satellite tagging will be conducted by ADF&G; lipid analyses and interpretation by Dalhousie University; blood chemistry analyses at UAF; and statistical modeling by ADF&G and UAF. Inclusion of interdisciplinary components within the same project will ensure that data are shared and interpreted in an interdisciplinary manner.

This project will provide logistics, the MMPA permit to conduct sampling, and access to seals and samples for this study and for a study by Dr. Jennifer Burns (Moss Landing Marine Laboratory, California) regarding pup physiology. Harbor seal investigators at ADF&G and other universities have been working successfully together for the last eight years on harbor seals in PWS and elsewhere, and future collaborations should be equally productive. Regular meetings and seminars are held by marine mammal investigators at UAF and ADF&G Fairbanks to exchange information and ideas.

Statistical modeling to assign quantitative values to seal diets based on fatty acids signatures will be done as a cooperative effort between this restoration study and Scotian Shelf research project, with partial support from NSERC.

This harbor seal study has obtained samples of prey and incorporated results from Herring (ADF&G) and SEA studies being submitted under the PWS System Investigation, and from the study Apex Predator Ecosystem Experiment. In the future, as large scale fisheries surveys receive less funding, we expect most of our samples to come from routine ADF&G operations. Prey samples from the GOA and SEAK will also be obtained on an opportunistic basis, in cooperation with other ADF&G harbor seal studies and with National Marine Mammal Laboratory (NMML) sea lion projects. These samples will be analyzed with non-EVOS funding, but analyses will be included in the results of the project. Fatty acids analysis in the future will emphasize pollock, herring, capelin, and sand lance, and any new species found to be important in the diet of seals near glaciers. These species are important to seabirds and to harbor seals.

ADF&G harbor seal investigators are currently and will continue to participate in interactive discussions with subsistence hunters in PWS and the GOA the Alaska Native Harbor Seal Commission. These discussions include the ongoing harbor seal decline, communication of results of Restoration-funded studies, and suggestions for future research.

ADF&G receives funding from NOAA to conduct complementary studies of harbor seals in the northern GOA and SEAK. This funding provides an "economy of scale" for many aspects of both studies. For example, disease and genetics analyses of PWS seals have been done at minimal or no cost to this study, but are instead provided through the NOAA-funded harbor seal study. Equipment is shared and analytical techniques and software developed by one project can be used by the other.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This project is a logical follow-up to Project 064, which focused on harbor seals using rocky haulouts in southern and central PWS. Project 064 developed new techniques for catching and tagging seals; provided unprecedented information about the movements and diving behavior of seals in PWS; proposed significant new methods for statistical analysis of aerial survey data; and was instrumental in the development of new techniques that use fatty acids analysis to investigate and document changes in diet. The next step for PWS harbor seal research is to determine how studies conducted on seals using rocky intertidal habitats in southern and central PWS relate to glacial ice seals of northern PWS. These glacial ice seals constitute more than half the total seals in PWS. They are almost certainly less subject to tidal influence, and perhaps more subject to time of day. It is unknown whether they feed immediately adjacent to the glaciers, or travel elsewhere to feed in the same places as other PWS seals. Nothing at all is known about where glacial ice seals go in winter. The major focus of this new study will be to systematically address these questions. All methods will be designed to assure comparability and facilitate comparisons with data from previous studies conducted under Project 064. This will continue fatty acid analysis, analysis of satellite tagging data from pups, D_2O studies of body condition; and statistically robust aerial survey techniques. Annual molt-period surveys of trend route A, as well as the new glacier route, will continue. Seals will be sampled for fatty acids and body condition in both glacial habitats and rocky intertidal habitats in each year to facilitate annual as well as habitat comparison.

PROPOSED PRINCIPAL INVESTIGATOR

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PERSONNEL QUALIFICATIONS

Kathryn Frost (the principal investigator) has conducted research on marine mammals in Alaska since 1975. She has undertaken extensive research on natural history and ecology of seals, including aerial surveys; studies of food habits and trophic interactions; and studies of habitat use using satellite tags. She has conducted extensive aerial surveys of harbor seals in PWS and boat-based observations and sampling of harbor seals as part of NRDA studies following the EVOS. She has conducted satellite tagging studies of harbor seals in PWS from 1991 through 1998.

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

Rob DeLong is an Analyst Programmer for ADF&G. He has developed custom software for analysis of data from satellite-tagged seals. Mr. DeLong is also accomplished in seal catching and tagging techniques.

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

Grey Pendleton is a Biometrician for ADF&G with extensive background in analyzing satellite tagging and aerial survey data. He will be responsible for statistical analysis of satellite tagging data for this and other ADF&G harbor seal projects.

Dr. Sara Iverson is an Assistant Professor at the University of Dalhousie. She is currently conducting research at Sable Island, Nova Scotia, on the lipid metabolism of seals and the use of fatty acids to determine marine food webs. She received her Ph.D. in nutritional sciences, conducting studies of the energetics of reproduction and fatty acid metabolism in seals. She developed procedures for analysis of lipids in milk, blubber and tissues of pinnipeds. Dr. Iverson has published extensively on these subjects.

KEY PERSONNEL

Kathryn Frost:	Project management and coordination, planning, data analysis, reporting, seal tagging, aerial surveys
Lloyd Lowry:	Permitting, tagging, GIS analysis, coordination with other ADF&G studies
Robert DeLong:	Tagging, programming, GIS analysis of SDR data
Jay Ver Hoef:	Statistical analysis of survey data, tagging
Grey Pendleton	Statistical analysis of tagging data
Sara Iverson:	Fatty acid analysis and interpretation

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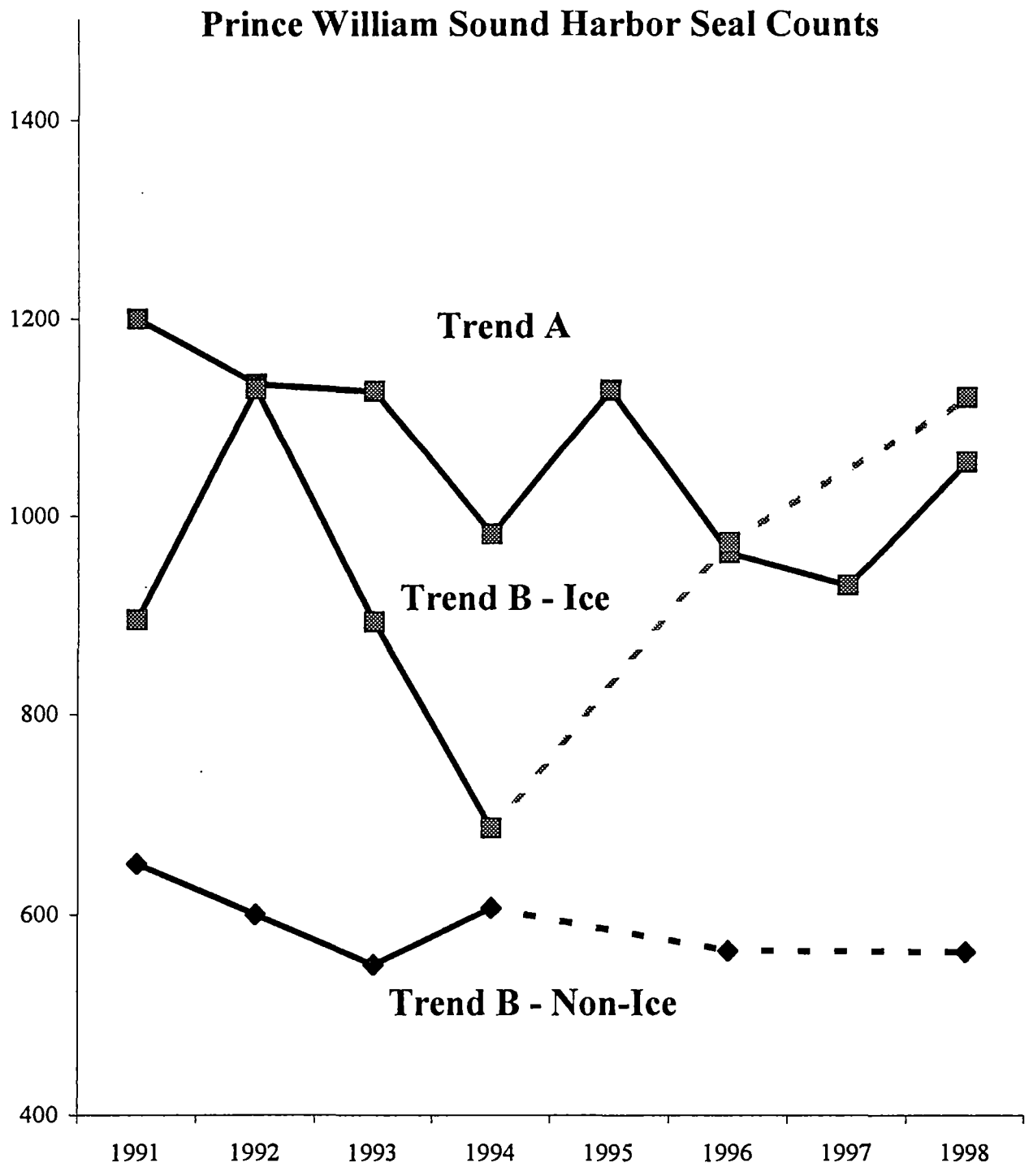

Figure 1. Harbor seal counts along Trend Route A and ice (glacial) and non-ice haulouts of Trend Route B, 1991-1998. Data for Trend Route B are from Burns (unpubl. data).

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

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$41.9
Travel		$3.7
Contractual		$35.4
Commodities		$32.6
Equipment		$0.0
Subtotal	$0.0	$113.6
General Administration		$8.8
Project Total	$0.0	$122.4
Full-time Equivalents (FTE)		0.8

LONG RANGE FUNDING REQUIREMENTS

		Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
		$225.0	$175.0		

Dollar amounts are shown in thousands of dollars.

Other Resources

Comments:
This proposal is for the last year of an ongoing harbor seal study. It provides information on population trends, movements, and ecology of harbor seals, including changes in diet, in order to identify causes of the apparently ongoing decline among harbor seals in central PWS. Emphasis in FY 00 will be on analysis of previously gathered telemetry data on adults and preparation of manuscripts dealing with fatty acids analyses, modeling population dynamics relative to carrying capacity, Bayesian survey analysis, and diving behavior of seals.

None of the costs identified in this budget are for NEPA compliance. Marine mammals projects obtain permits required under the Marine Mammal Protection Act from NOAA as part of routine operations. Costs for meeting attendance are identified under travel and total $3.7 K. This includes attendance at the annual EVOS workshop, and two persons to present papers at the 13th Biennial Marine Mammal Conference.

The proposed FY 00 budget is within the guideline presented in the FY00 Invitation to Submit Restoration Proposals. This project achieves major cost savings by collaborating with other studies and agencies to conduct this work. For example,ADF&G receives funds to conduct harbor seal studies in other parts of Alaska. This enables investigators to share costs for equipment, computers and software, as well as new methodologies and approaches to data analysis. Costs for fatty acid model development will be shared with Scotian Shelf research projects. Fatty acid samples to be use din comparisons of PWS and other geographic areas will be provided by other ADF&G harbor seal studies.

FY00

Prepared: 4/8/99

Project Number: 00564
Project Title: Harbor Seals on Glacial Ice in Prince William Sound: Habitat Use,Trophic Interactions and Abundance
Agency: ADF&G

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
K. Frost	WBIII - Program Coordinator and Mngt	18K	2.0	6.5		13.0
L. Lowry	WBIV- Sat Tag Analysis & Interpretation	20J	1.0	7.0		7.0
R. DeLong	Analyst Programmer III-GIS Programming	17F	1.0	6.0		6.0
J. Ver Hoef	Biometrician II - survey statistical analysis	19F	0.5	6.4		3.2
G. Sheffield	WBI - data anlysis and graphics	14A	1.0	4.0		4.0
G. Pendleton	Biometrician II - sat tag analysis	19B	0.5	5.3		2.7
To be determined	Graduate student intern - sat tag analysis	12A	3.0	2.0		6.0
		Subtotal	9.0	37.2	0.0	
					Personnel Total	$41.9

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
Fbks-Cordova for Aug surveys, 1 person - included in 00064 proposal					
Fbks-Anchorage, annual workshop, 1 person - included in 00064 porposal					
Fbks-Anchorage, tagging, 1 person X 1 field trip	0.3	1	2	0.1	0.5
Portage-Whittier by train (2 vehicles per trip)	0.8	2	0	0.0	1.6
Fbks-Portage, personal vehicles	0.3	2	0	0.0	0.6
Fbks-Santa Cruz, tagging, sampling & physiology, 1 person	0.8	1	2	0.1	1.0
				Travel Total	$3.7

FY00

Prepared: 4/8/99

Project Number: 00564
Project Title: Harbor Seals on Glacial Ice in Prince William Sound: Habitat Use,Trophic Interactions and Abundance
Agency: ADF&G

FORM 3B
Personnel
& Travel
DETAIL

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

Contractual Costs:	Proposed
Description	FY 2000
NOAA contract and ARGOS expenses for ARGOS satellite data, June 00 tags	9.0
Print/graphics (slides for workshops, report production)	0.3
Postage (DHL, courier, etc.)	0.3
Lipid analysis contract with Dalhousie University (additional to 00064 proposed amount)	10.0
Freight and shipping of samples	0.5
Trailer parking & launch fees, Whittier ($100/vehicle X 2 vehicles)	0.3
Vessel charter for tagging/sampling @ 1.5/day x 10 days	15.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$35.4

Commodities Costs:	Proposed
Description	FY 2000
Misc. field and meeting supplies (notebooks, marine charts, film, etc.)	0.3
Computer supplies and software for graphics, GIS, and other analyses	1.0
Seal nets for catching seals in glacial ice	1.5
Fuel for boats and skiffs	0.5
Biopsy punches, flipper tags, epoxy. tag supplies, film	0.8
Small boat supplies (propellers, oars, oil, etc.)	0.8
Laboratory supplies (D2O, cryovials, vacutainers, etc.)	1.5
Repair supplies for skiffs, net, etc.	1.0
6 satellite tags @ $4.2/unit (from Wildlife Computers)	25.2
Commodities Total	$32.6

FY00

Prepared: 4/8/99

Project Number: 00564
Project Title: Harbor Seals on Glacial Ice in Prince William Sound: Habitat Use,Trophic Interactions and Abundance
Agency: ADF&G

FORM 3B
Contractual & Commodities DETAIL

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
			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
Equipment used by project, purchased with oil spill funds		
Leitz binoculars	1	ADF&G
HP LIID Printer	1	ADF&G
Compaq 286 Computer	1	ADF&G
Zodiac Raft	1	ADF&G
Equipment used by project, but purchased with non-oil spill funds		
20 ft Boston whaler	1	ADF&G
17 ft Boston whaler	1	ADF&G
Seal nets	1	ADF&G
2 486 computers + Plotter	1	ADF&G
Printer	2	ADF&G
Color printer	1	ADF&G

FY00

'Prepared: 4/8/99

Project Number: 00564
Project Title: Harbor Seals on Glacial Ice in Prince William Sound: Habitat Use,Trophic Interactions and Abundance
Agency: ADF&G

FORM 3B
Equipment
DETAIL

Monitoring Environmental Contaminants in the Northern Gulf of Alaska

Project Number:	00 567
Restoration Category:	Monitoring
Proposer:	Alaska Department of Environmental Conservation
Lead Trustee Agency:	Alaska Department of Environmental Conservation
Cooperating Agencies:	Alaska Department of Health and Social Services
Alaska Sealife Center:	No
Duration:	One Year
Cost FY 00:	76.2
Cost FY 01:	0.0
Cost FY 02:	0.0
Geographic Area:	Spill-Impacted Area
Injured Resource/Service:	All injured resources and services

ABSTRACT

This project will assess needs and priorities for monitoring environmental contaminants in the northern Gulf of Alaska, including the area directly affected by the Exxon Valdez Oil Spill. It will evaluate information on water quality, marine species' sensitivities to pollutants, and contaminants that pose potentially adverse effects to the ecosystem and to human health. Recommendations will specify priorities for monitoring of contaminants in order to track lingering oil spill injury, trends and potential effects of pollutants.

INTRODUCTION

The state currently has no long-term program to monitor environmental pollutants such as petroleum hydrocarbons in species of marine organisms. In the northern Gulf of Alaska and area of the oil spill, scientists, managers and concerned citizens been challenged by the absence of background levels or trends to compare with effects of exposure to the chemical constituents of crude oil and other pollutants.

The presence of industrial contaminants in aquatic environments has resulted in worldwide concerns about the potential effects on marine organisms and on human consumers. Polyaromatic hydrocarbons (PAHs), constituents of natural and manmade petroleum products, have been increasingly detected in marine organisms and have been documented in EVOS field research. Persistent organic pollutants such as polychlorinated biphenyls (PCBs) and organochlorine pesticides have been found throughout the world and can be detected in the environment in trace quantities. They can be transported great distances on wind and ocean currents following their accidental release from industrial countries. Mercury and other metals such as inorganic arsenic, mercury, cadmium, and selenium are naturally present in the environment in low amounts, but industrial sources contribute additional quantities.

Some persistent organic pollutants, pesticides, heavy metals and petroleum constituents can bioaccumulate in marine organisms. Many of these chemicals can cause adverse health effects in people at increasing levels of exposure. Although chemicals of concern have been detected at generally low concentrations in some Alaskan marine biota, there is increasing evidence that some effects can occur in humans at relatively low levels. Effects can be further magnified in developing infants and young children.

There is very little information available from Alaskan marine species to assess possible trends, associated variability, or combined effects from more than one contaminant. Without such information, it remains problematic to assess and predict risk. Currently, Alaska does not have an ongoing capability to assess and monitor environmental pollutants to provide vital information needed by scientists, resource managers, and consumers.

NEED FOR THE PROJECT

A. Statement of Problem

Based on sound science conducted to date through EVOS restoration research and other programs, an assessment of priorities is needed for monitoring environmental contaminants in the northern Gulf of Alaska ecosystem. This in turn will provide basic capability to adequately document conditions, detect trends, and manage pollutants to protect natural resources.

As an additional benefit to the public, an effective monitoring program would also provide key information to indicate whether there are levels of contaminants that warrant more intensive investigation. For example, if the monitoring program detected a contaminant in a fish species

used by humans, it could serve as an "early warning system" to alert resource managers. Although the proposed contaminants monitoring program would not have the required sampling intensity of a fish consumption advisory program, it would help indicate priorities for further assessment. This would help ensure more effective use of limited funding resources, because Alaska is among the few states with no formal advisory program to address chemical contaminants and fish consumption.

The Alaska Department of Environmental Conservation, in close coordination with other interested agencies, proposes to contractually obtain specialized scientific expertise regarding contaminants, water quality, and marine organisms to evaluate existing data and concerns, and to develop recommendations for long-term monitoring.

This project schedule and scope is specifically designed to complement and fit within a more comprehensive effort to define restoration and research and Trustee Council priorities for long-term environmental monitoring. This is described in a memo from the Executive Director to the Trustee Council; entitled "Development of Draft Long-term Research and Monitoring Plan" dated April 13, 1999.

B. Rationale/Link to Restoration

Pollutants entering marine waters are affecting resources and human uses injured by the oil spill. Human population growth, industrial activities and waste disposal are increasingly contributing pollutants from local, regional, and international sources. Faced with these pressures, resource managers need accurate, up to date information on conditions and changes over time to protect resources from harm, and to guide restoration decisions. The public needs accurate information to make informed recommendations and choices. Because local residents rely heavily on the abundance, quality and safety of marine species used as food, communities affected by the spill need assurance that local conditions are being monitored.

This project will further an understanding of fate and transport of pollutants in the Alaskan marine environment. This in turn will enhance the ability to make informed restoration decisions, and to find effective ways to identify, prevent, or limit pollution sources and associated damage.

C. Location

The geographic scope of the information assessed and resulting recommendations from this project will be Prince William Sound and the northern Gulf of Alaska. Communities with potential to benefit from the project include Valdez, Cordova, Chenega, Tatitlek, Whittier, Tyonek, Nanwalek, Port Graham, Seldovia, Homer, Soldotna, Anchorage, Kodiak, Pt. Lyons, Ouzinkie, Old Harbor, Akhiok, Chiniak, Karluk, and Larsen Bay. The project does not involve fieldwork.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

People in the areas affected by the oil spill remain highly concerned about the safety of their local natural resources. Communities will be actively encouraged to participate in this project by reviewing the synthesis of current information about species, including those used for subsistence. Community support is key to ensuring that the summary information portrays actual resource usage, and that the monitoring recommendations will help address local concerns.

PROJECT DESIGN

A. Objectives

1. Determine current data sources on environmental contaminants, including data for water quality and sediments.

2. Assess what we have learned about contaminants from EVOS and other research on levels, trends and sensitivities in marine species.

3. Assess the greatest concerns to the marine ecosystem, and to human consumers of marine organisms.

4. Identify data gaps.

5. Develop recommendations for long term monitoring of environmental contaminants.

B. Methods

The Alaska Department of Environmental Conservation, with the approval of a steering committee, will release a Request for Proposal. The committee will consist of representatives from ADEC, the Alaska Department of Health and Social Services, the Trustee Council member agencies, and the EVOS Chief Scientist. Once all the proposals have been received, the evaluation team will determine the successful candidate based upon a scoring system.

The work product for this project will be a report produced by the contractor. Community representatives, steering committee members, and additional specialists will review the draft reports. The final report will be presented to the Trustee Council by DEC in accordance with the "Procedures for the Preparation of Final Reports."

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The ADEC will rely on assistance from the Alaska Department of Health and Social Services (DHHS) during this project to help provide expertise on the relationship of contaminants to human health. Other agencies are currently expressing interest in this project concept, such as

U.S. Geological Survey, U.S. Fish and Wildlife Service, Alaska Department of Fish and Game, and U.S. Environmental Protection Agency. The ADEC will seek further involvement from interested agencies.

SCHEDULE

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

October 1	Steering committee publishes RFP
November 1	Select qualified applicant to carry out project
January 3	Draft report provided to project reviewers
January 31	Revised final report to submit to Trustee Council Chief Scientist

B. Project Milestones and Endpoint

November 11	Contract in place
January 3	Draft report available for review
January 31	Final report to Trustee Council Chief Scientist

C. Completion Date

March 1, 2000

PUBLICATIONS AND REPORTS

The final report will be prepared and submitted to the Trustees Council, as previously described.

PROFESSIONAL CONFERENCES

The results of the project will be presented at the annual EVOS symposium.

NORMAL AGENCY MANAGEMENT

The project is not a requirement of state statute or regulation. State agencies do not currently have in-house expertise or resources to carry out the extensive data synthesis required by this project. The project approach has not been addressed previously by the Trustees Council.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The timing and focus of this project are specifically designed so that the results can be incorporated into a larger scoping effort to assess Trustee Council priorities for a long-term science plan.

EXPLANATION OF CHANGES IN CONTINUING PROJECT

Not applicable.

PROPOSED PRINCIPAL INVESTIGATOR

Marianne G. See
Alaska Department of Environmental Conservation, Office of the Commissioner
555 Cordova Street, Anchorage, Alaska 99501
907-269-7635 phone
907-269-7508 fax
msee@envircon.state.ak.us

OTHER KEY PERSONNEL

Agency representatives will be identified in the first project phase.

LITERATURE CITED

McCammon, Molly. April 13, 1999. "Development of Draft Long-term Research and Monitoring Plan". Memo to the Exxon Valdez Oil Spill Trustee Council. 7 pp.

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 – September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$7.9
Travel		$1.8
Contractual		$61.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$70.7
General Administration		$5.5
Project Total	$0.0	$76.2
Full-time Equivalents (FTE)		0.1
Other Resources		

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

Dollar amounts are shown in thousands of dollars.

Comments:

Contractor to be selected through RFP process (See 3B)
Personnel costs support agency participation in steering committee to develop RFP and to review draft proposals
Travel for one agency representative to Anchorage to participate in steering committee

FY00

Prepared:

Project Number: 00567
Project Title: Monitoring Environmental Contaminants
Agency: ADEC

FORM 3A
TRUSTEE
AGENCY
SUMMARY

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
Doug Dasher	Environ Cons Mgr & Arctic Contam Spc	20 M	0.5	7.3		3.7
Richard Barrett	Program Manager of ADEC, Lab Svcs	23 K	0.5	8.3		4.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Subtotal			1.0	15.6	0.0	
					Personnel Total	$7.9

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
One trip to Anchorage from Fairbanks to participate in steering committee	0.8	1	5	0.2	1.8
Includes rental car in per diem.					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.8

FY00

Prepared:

Project Number:
Project Title: Monitoring Environmental Contaminants
Agency: ADEC

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRUST[illegible]OUNCIL PROJECT BUDGET
October 1, 1999 tember 30, 2000

Contractual Costs:	Proposed FY 2000
Description	
Contractor to be selected through RFP process Bulk of contract to be personnel costs Travel includes 3 trips to Anchorage to meet with steering committee, reviewers, and annual symposium (estimated at 4.0 total) Supplies, production of report drafts, and final per EVOS procedures (estimated at 1.0 total) Includes contractor's indirect (estimated at 10%) Personnel costs estimated as an approximation (50.0)	61.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$61.0

Commodities Costs:	Proposed FY 2000
Description	
Commodities Total	$0.0

FY00

Prepared:

Project Number:
Project Title: Monitoring Environmental Contaminants
Agency: ADEC

FORM 3B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRUSTEE 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	Inventory Agency

FY00

Prepared:

Project Number:
Project Title: Monitoring Environmental Contaminants
Agency: ADEC

FORM 3B
Equipment
DETAIL

2000 EXXON VALDEZ TRUST[illegible]COUNCIL PROJECT BUDGET
October 1, 1999 [illegible]tember 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$7.9						
Travel		$1.8						
Contractual		$61.0						
Commodities		$0.0						
Equipment		$0.0						
Subtotal	$0.0	$70.7			Estimated FY 2001	Estimated FY 2002		
General Administration		$5.5						
Project Total	$0.0	$76.2			$0.0	$0.0		
Full-time Equivalents (FTE)		0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Contractor to be selected through RFP process (See 3B)
Personnel costs support agency participation in steering committee to develop RFP and to review draft proposals
Travel for one agency representative to Anchorage to participate in steering committee

FY00

Prepared:

Project Number:
Project Title: Monitoring Environmental Contaminants
Agency: ADEC

FORM 3A
TRUSTEE
AGENCY
SUMMARY

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
Doug Dasher	Environ Cons Mgr & Arctic Contam Spc	20 M	0.5	7.3		3.7
Richard Barrett	Program Manager of ADEC, Lab Svcs	23 K	0.5	8.3		4.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.0	15.6	0.0	
					Personnel Total	$7.9

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
One trip to Anchorage from Fairbanks to participate in steering committee	0.8	1	5	0.2	1.8
Includes rental car in per diem.					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.8

FY00

Prepared:

Project Number:
Project Title: Monitoring Environmental Contaminants
Agency: ADEC

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed FY 2000
Description	
Contractor to be selected through RFP process Bulk of contract to be personnel costs Travel includes 3 trips to Anchorage to meet with steering committee, reviewers, and annual symposium (estimated at 4.0 total) Supplies, production of report drafts, and final per EVOS procedures (estimated at 1.0 total) Includes contractor's indirect (estimated at 10%) Personnel costs estimated as an approximation (50.0)	61.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$61.0

Commodities Costs:	Proposed FY 2000
Description	
Commodities Total	$0.0

FY00

Prepared:

Project Number:
Project Title: Monitoring Environmental Contaminants
Agency: ADEC

FORM 3B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRUSTEE 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	Inventory Agency

FY00

Prepared:

Project Number:
Project Title: Monitoring Environmental Contaminants
Agency: ADEC

FORM 3B
Equipment
DETAIL

TITLE: Historic, contemporary, and near-real-time meteorological data. Low cost open access to the EVOSTC and OSRI acquisitions for the EVOS spill-affected region, 1972 to the present. Submitted to NOAA under BAA

00568

PRINCIPAL INVESTIGATOR:
Stephen Bodnar
Computing Systems Manager for
Prince William Sound Sci. & Tech. Inst.
and the
Oil Spill Recovery Institute
Cordova, AK 99574

CO-INVESTIGATOR:
Vincent Patrick
Advanced Visualization Lab
University of Maryland
College Park, Maryland 20740
and
Prince William Sound Sci. & Tech. Inst.

NEW/CONTINUATION: New

DURATION: 1 Year

PROPOSED START DATE: 1 July 1999

AMOUNT REQUESTED: $39,500

Historic, contemporary, and near-real-time meteorological data. Low cost open access to the EVOSTC and OSRI acquisitions for the EVOS spill-affected region, 1972 to the present.

A project providing improved cost-efficiency for all EVOSTC restoration and enhancement projects, contributing to the repository and distribution mission objectives of three major state and federal programs, and proposed in concert with three regional oversight and industry-support organizations

PROJECT SUMMARY

A combined archive of historic, contemporary, and near-real-time meteorological data for the Exxon Valdez spill affected regions now exists. As this project summary is being read the archive will have been expanded and updated no more than 30 minutes ago by a variety of automated activities.

At the top of the hour an automated query was made of the METAR data system. The archive was then updated and expanded by any new reports from the METAR sites located in the spill-effected region. This automated system is a product of the Exxon Valdez Oil Spill Trustee Council (EVOSTC) and is now maintained by the Oil Spill Recovery Institute (OSRI).

At the top and the bottom of every hour the archive will have been expanded by the data from a variety of Special Projects and New Stations. These new data will have come from those Special Projects and New Stations using the Information System at this site for their data communications, aggregation, management, distribution, and station maintenance. The data just received from Special Projects and New Stations (contingent upon program schedules) has arrived from five new fixed meteorological stations and from six to ten automated mobile stations presently undergoing prototype trials.

Two further archive updates during the hour came from sites that until recently were considered Special Projects but are now well established and routinely queried by NWS for use in operational forecasting: the Applegate Rock meteorological station and the Cordova meteorological station at the Prince William Sound Science Center dock. Both of these stations are products of EVOSTC and are maintained by OSRI.

Two grants have been awarded to this group from OSRI to establish and maintain an Information System (IS) that will support the OSRI projects in Prince William Sound (PWS). The two OSRI grants, along with a third co-funding grant, now provide support sufficient to sustain the present computational and telecommunications services of the Information System at this site.

This group can therefore offer to EVOSTC a low-cost prototyping project wherein all components of the EVOSTC/OSRI meteorological archive just described are maintained as an on-line, open access information resource.

This on-line service format has been provided in a demonstration format throughout the past three years as part of a prior EVOSTC effort. The demonstration format is still available on-line but is not now actively maintained. However, as a result of the demonstration period, there is an established record whereby the value to stakeholders and to EVOSTC restoration and enhancement projects can be readily reviewed and evaluated.

The proposed project requests personnel support only; all other costs are covered by co-funding.

The projects costs are a small fraction of the costs that would be incurred if even a handful of EVOSTC efforts were individually purchase, assemble, and reconstruct any significant fraction of the historic and the contemporary archive. (See the tabulation of the scope of the historic and contemporary archives.) Moreover, the near-real-time METAR archive and the near-real-time records from Special Projects and New Stations would be accessible only through an expensive process of individual end-user inquiry and cost re-imbursement, or at the end of the month if repository agencies assume the costs for data collection, quality control, and distribution of Special Project data. Information from prototyping trials would be accessibly only through an inefficient process of negotiation and cost reimbursement by end-users with each of the agencies or research groups conducting the trials.

This project would enable both EVOSTC and OSRI to eliminate the added costs and project delays that are a routine aspect of finding and acquiring necessary information resources, especially in the case of near-real-time information and information from new development efforts. It also eliminates costs for duplicated efforts and acquisitions. In addition to simple cost reduction, this project provides both EVOSTC and OSRI significantly greater returns, in terms of progress with their respective mission objectives, from their past and continuing investments in meteorological data.

It is proposed that EVOSTC use this project for a second purpose:

to explore methods that are most effective for the project management of technology projects having restoration applications and enhancement services as their goals. There will be increasing interest by stakeholders and end-users in seeing the scientific findings of the restoration programs brought to bear upon the social and economic issues of current interest in the spill-effected regions. The activities that tackle such tasks are areas of national interest and are referred to as "rapid prototyping" and "time-to-market" development issues. In many areas of technology the national successes in these areas are credited with the national economic successes while much of the world economies are having difficulties. This project is proposed as a "rapid prototyping" effort, for it has as its goal maximum efficiency and immediacy in the transfer of spill-area meteorological information, from both repository and new development sources, to end-users.

The question that arise for EVOSTC are what project formats, incentives, and performance measures are most effective for obtaining effective and rapid transfer of scientific findings into "things" that pass directly into value to end-users, or pass from scientific findings into application development, or from that development into services. In such cases the basic science performance measures of peer-review and publications do not suffice. Performance measures become more application and utilization specific. This small project can be used as a test case early in this anticipated phase in such measures will become ever more important.

These issues of efficiency and timeliness are not unique to the science and technology areas of interest to EVOSTC but occur in every area. A unique aspect of the group making this proposal is the breadth of the technical areas represented. This breadth offers to EVOSTC the means to examine the strategies currently employed by efforts ranging from data mining projects at NSF, space physics and magnetic storm projects in NASA, to operational weather forecasting in NWS.

The project does not in anyway seek to duplicate the superb services now provided by state and federal offices, especially those of NCDC and NDBC in NOAA, but rather to provide an incremental cost savings to those services through complementary and supplementary tasks described herein. Indeed, this proposal is not possible without the continued national investment in the services presently provided by the NOAA divisions. The cost savings and efficiencies of this effort are possible only under the assumption that the current federal policies for information dissemination and the implementation of those services by the various NOAA offices are continued.

BACKGROUND AND RATIONALE

During the period of 1994 to the present the following datasets were acquired in support of a wide variety of projects.

Historical

Middleton Island:	Nov. 1, 1977 - Aug. 31, 1998	NCDC
Valdez 1:	Dec. 31, 1994 - Aug. 31, 1998	NCDC
Valdez 2:	Jan 2, 1995 - Aug. 31, 1998	NCDC
Whittier:	Dec. 31, 1994 - Aug 31, 1998	NCDC
Cordova Mile 13:	Jan. 1, 1984 - Aug. 31, 1998	NCDC
Cordova North:	June 1, 1955 - June 31, 1998	NCDC
Cordova Water Treatment Plant:	Jan. 1, 1980 - Dec. 2, 1992	City of Cordova
buoy 46001:	Oct. 2, 1972 - Dec. 1, 1998	NDBC
buoy 46009:	Dec. 14, 1977 - Oct. 6, 1979	NDBC
Armin F. Keornig Hatchery:	all records	PWSAC
Wally H. Norenberg Hatchery:	all records	PWSAC
Cannery Creek Hatchery:	all records	PWSAC
Main Bay Hatchery:	all records	PWSAC

Contemporary (1995 -- 1999)

buoy 46060:	May 16, 1995 - Dec. 31, 1998	NDBC
buoy 46061:	May 16, 1995 - Dec. 31, 1998	NDBC
CMAN blia2:	May 19, 1995 - Dec. 31, 1998	NDBC
CMAN pota2:	May 26, 1995 - Dec. 31, 1998	NDBC
CMAN mrka	Sept. 20, 1997 - Dec. 31, 1998	NDBC
Applegate Rocks:	June 5, 1996 - Nov. 30, 1998	PWSSC
PWS Science Center:	Dec. 2, 1995 - Oct. 31, 1998	PWSSC

Near real-time

PAAQ Palmer
PABN Nabesna
PACV Cordova Mile 13 Airport
PADQ Kodiak
PADT Slana
PAGK Gulkana
PAHO Homer
PAJV Sutton
PAMD Middleton Island
PAMX McCarthy
PANC Anchorage International Airport
PASP Sheep Mountain
PATO Portage
PAVD Valdez
PAVW Valdez
PAWD Seward
PAWR Whittier
PAXK Paxson
PAYA Yakutat

Special Projects and New Stations

The collection of Special Projects and New Stations is, of course, continually changing as new projects and stations appear and then later transition into something operational or complete the mission objective. At the time of this submission each of the following Special Projects or New Station is either in underway or is nearly certain of commencing prior to the time of the review of this submission.

(1) The automated METAR system is only on half of the full automated system. The second half consists of the same functionality but for the present set of PWS tanker lane buoys and CMAN stations provided by NOAA NDBC. The software and dedicated hardware providing the same services as the METAR system (described in the Summary) is now in preparation.

Two new projects have been initiated cooperatively with the National Weather Service Forecast Office in Anchorage, Alaska to provide additional meteorological stations in and around Prince William' Sound. Each of the sites is known to have unique localized wind events that are significant with respect to small vessel navigation and safety and air-sea coupling in circulation models, and that are not presently recorded by existing stations. The new sites have been selected to capture these localized weather processes and also to use most efficiently existing inter-agency and private infrastructure. The cost efficiency realizable through this last feature has been a key factor in the progress to date in this joint effort with NWS. The following two Special Projects are the second and third in the present (and every changing) listing:

(2) To establish four new fixed automated reporting stations:
- 3 in western PWS, and
- one on the Copper River Flats.

(3) Design and deploy portable systems for small vessels.
Each system will upload meteorological, positional, and, optionally, oceanographic data automatically via satellite.

All of the data feeds from the foregoing and similar new Special Projects and New Stations would be made available as part of this effort. The project would provide the information in near real-time and it would construct, manage, and maintain the information in an archived format. The personnel time for management, documentation, and quality control is included in the project costs and schedules. The costs for siting, installation, site maintenance, and system development are not part of this request.

VALUE OF THE ARCHIVE

There are initial acquisition costs for the historic components of the archive. The cost to purchase the data available from NCDC is $5000. The other offices provide data on a case-by-case basis and can be expected to request some cost-recovery for time involved in data extraction, formatting, packaging and shipping. None of the historical data is available on-line.

To this acquisition cost must be added the personnel costs associated the various procurement and data specification tasks. These tasks include specification of station and time period, specification of data format (WBAN, DATASAV2, or GLOBALSOD), and specification of digital media (e.g., DAT, Exabyte, CDROM, floppy disk). All data formats are not equivalent, and the format must be evaluated to determine if any subsetting or summarization will impact the end-use objectives. Once the format is specified, the end-use data format must be specified for each application scenario. Having selected the repository format and specified the end-use format, programming support services can then address the task of software or scripts for converting the repository format into the specified application format or into a format recognizable by end-use proprietary software applications.

The data shown in the contemporary archive section is available on-line. The costs are those associated with downloading the data and the various data manipulation and programming tasks to convert the on-line information into a format compatible with end-use requirements. A frequent issue is that the archive size is typical one-year, and the file size exceeds the capacity of many PC spreadsheets of recent vintage. Some programming support is often needed to reduce the archive size for software geared for business and productivity applications.

The near real-time METAR archive requires the end-user to configure and maintain the software and telecommunications described in the summary. The information at the METAR online repository persists only for 24 hours and is then overwritten by new data. Thereafter, the earliest time at which the information will again be available is at the end

of the current month at which time an archive dataset for the month becomes available for purchase from NCDC.

The near real-time data and the archive data from Special Projects and New Stations similarly requires the query and automation software and the telecommunications necessary to extract of postings of the agency handling the downlink archive for the New Stations projects. The precise requirements depend on which agency will be receiving and managing the data and into whether the data goes into an operational or experimental forecast office. In general, an effort similar to the one proposed here would be required for each and every end-user. This group is pursuing every possible means to find the support whereby these near-real-time data from New Stations are available on-line.

Lacking this proposed project, an end-user has even greater obstacles to overcome to obtain near-real-time data from development oriented Special Projects. These projects have as their priority the technical and scientific questions for which the project is being conducted and typically do not have the added resources to support on-line services. Even in cases in which end-users have the option of full reimbursement to the development project for the additional personnel time, those personnel resources simply may not be available to the project. Development projects often have no information delivery and archiving requirements; therefore there is no budget and no plan for information dissemination, distribution, and archiving. In such cases not only near-real-time data but also the entire data archive is either lost or never reported.

It is easy to see how a duplication of even a fraction of the proposed effort by only a handful of restoration projects can easily lead to total expenditures for EVOSTC or OSRI, or both, that are several times this request for the support for personnel costs.

The foregoing costs are in all cases based upon the cost to users under the current NOAA operational policies. During the past ten years NOAA has been at the forefront of efforts to provide to the nation low cost information resources along with the infrastructure needed for support and timely delivery. The pricing strategies are based on a very highly subsidized structure with modest or no cost-recovery charges. Thus, the costs above are by no means high but rather represent a remarkable national asset. Under current operational policies, NOAA imposes only the requirements of proper attribution and proper practices for data integrity for information redistribution. As a consequence, this project can provide complementary and supplementary functions providing increased cost efficiency, wider accessibility, and enhanced utility, especially for non-commercial, small business, and private end-users and stakeholders.

This approach has at various times over the past three decades not always been the national policy. One well known example is that of LANDSAT images. The cost per image of $5000 and up illustrates the alternative approach wherein the recovery of essentially all operational costs must be provided by the end-users.

As long as the current NOAA services are continued, it is practical for a medium sized R&D project (e.g., the EVOSTC SEA program) or an initiative with profit potential to undertake the assembly of an archive such as the one described herein for the spill-effected region. For small projects with very tightly structured cost allowances and with tightly specified project objectives and timelines, the present NOAA dissemination policies are even more critical and essential to their access to information resources.

This project supplements the NOAA objectives by adding on-line access to near-real-time information from Special Projects and New Stations, activities that are in the early phases of development and that address very local and site specific issues. The mission objective of this Information System is to support such R&D activities. Its existence provides the opportunity for low-cost on-line access to the resulting meteorological information. The project performance criteria is to execute those functions a manner that addresses and is adaptive to the unique interests of end-users and stakeholders, including all EVOSTC and OSRI sponsored projects.

EXAMPLES OF PAST UTILIZATION

The following examples are ones for which we have first hand, direct knowledge of the user and the usage. There are additional records of usage that can be recovered from system logs from the demonstration web site "Sound Report" (www.pwssc.gen.ak.us/sea/weather/realtime.html). The usage from these logs requires a user follow-up process that was not part of the demonstration effort, so these logs will not be used in this utilization report. Because the demonstration site is only a fraction of the archive in some cases queries could not be immediately serviced and users had to directed to the NOAA archives, all of which can be accessed through the links on the demonstration page.

sea otter overwintering

> In 1997 Dr. Brenda Balachey requested meteorological data for western PWS for use in here studies of sea otter overwintering survival. She was provided with temperature information from Applegate Rock station and was directed to those PWSAC observations available from NDBC on-line. (This query highlights the significance of the Applegate Rock station for the regions west of the tanker lane and the existing stations.)

PWS Risk Assessment Study

> During 1996 the PWS Regional Citizens Advisory Counsel, shippers, the Coast Guard, and others conducted a Risk Assessment study. The present introduction of the new generation of escort tugs is a major result of that effort. This project provided to the technical group at George Washington University the ten year archive of Middleton Island meteorological data, one of our first major purchases from NCDC. The data had reformatted from the DATASAV2 format to a tabular format and was made available to the Risk Assessment group by anonymous ftp. The time savings to the Risk Assessment can safely be estimated at several days and associated paperwork. The contribution is acknowledged in the Risk Assessment Report.

Circulation model simulations shown in the SEA Final Review, March 1999

> The full contemporary archive for 1996 is used, in conjunction with a wind interpolation scheme, to provide the hourly, gridded, surface wind stress presently used to force the SEA/EVOSTC/OSRI circulation model.

Charter vessel operations

Sea Sound Charters, a charter vessel business, has reported that the "Sound Report" web site is a routine part of their daily operations, providing the business with an assessment of the local weather conditions they will confront across all of Prince William Sound.

National Weather Service

The operational forecasts office in Anchorage makes regular checks of the two Special Projects sites established by EVOSTC, Applegate Rock and especially the Cordova station at Prince William Sound Science Center dock. This latter in particular is important to the forecast office for wind speed and wind direction information. This station provides extremes that were not seen until this site went online. The data from the station and used by the office in their operational forecasts.

OBJECTIVES; PERFORMANCE CRITERIA AND MEASURES

The primary objective is to make readily available to all stakeholders, including researchers, the existing and expanding meteorological data resources. The following are recommendations to EVOSTC for project performance criteria and the methods for measuring project performance against the suggested criteria.

1. Cost

   criteria: cost elimination

   measure: record of support requests for project tasks that duplicate the existing assets described herein.

   criteria: cost effectiveness, enhanced restoration project performance

   measure: restoration activities enhanced by the on-line and the near-real-time meteorological archive in conjunction with the proposed features.

2. Accessibility

   criteria: server up-time
   measure: Server system logs

3. Relevance to spill-effected region

   criteria: usage
   measure: System on-line activity logs: origins of query, destination of retrieved archives.

   criteria: utility of archive; effectiveness of archive

   measure: periodic request to end-users for evaluation reports

criteria: responsiveness

measure: on-line archive of received end-user requests for enhanced or modified archive services;
evaluation of effectiveness and appropriateness of solutions;
follow-up request to submitting end-user for evaluation.

4. Technical Significance

criteria: scope of on-line resources that otherwise are not available

measure: review by two professionals: one from meteorology, one from Information Technology.

APPROACH

The activities associated with the measurements or automated retrievals, that is, with the data that goes into the archive, are not part of this project. These activities either exist or are pending. This project addresses the support needed for maximal use of that information that is beyond the purposes and scope of the activities by which it is generated.

The approach in this effort is on-line accessibility by means of the basic and well established Internet protocols. The emphasis will be first on access using protocols that are well established and based on standards, and proceed from there to include more recent Internet services up to the point at which the maintenance costs created from non-standard services exceeds the projects target cost ceiling. The implementation sequence is first anonymous ftp and then web-based services.

A dedicated fte and web server will be configured. This server can be constructed primarily using available hardware with a few additions. The server will run Linux, an operating system increasingly adopted for such functions because of its well-known stability, up-time performance records, and very low initial cost (essential free) and extremely low maintenance and administration cost.

Software costs as well will be essentially zero. All software to be used has been released under the Open Source model and is freely available for public use. The software to be used includes the Apache web server, ProFTP or wu-ftp for the ftp server software, and the programming language Perl.

The following tasks or milestones are supported by the proposed project.

1. server hardware.
2. web and ftp server.
3. web browser interface design.
4. software to integrate these services with existing activities.
5. configure and modify the archive and database for support of the project objectives.
6. select an initial and small set of value-added services in the form of graphical query and display; one of the first such services will be graphical display of near-

real-time data to provide an easy and immediate assessment of the present local conditions across the region.

7. maintenance and updates for the foregoing tasks.
8. solicit user recommendations; adapt services if compatible with the project objectives and support ceiling.

SCHEDULE

Tasks 1 through 5 will be completed within two months following award.

Tasks 6 will be completed with three months of date of award.

Tasks 7 and 8 are ongoing throughout the remainder of the year.

CO-FUNDING

All sources of support for the Information System whereby this proposed

effort is possible is described in detail in the proposal and contract

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

The foregoing contract value is only one of the three co-funding sources that sustain the Information System. These additional sources add more that 50% again to the overall effort. Together these provide the systems, telecommunications, and systems administration required for the operations and services of the Information System upon which this effort is based.

The above document can be retrieved from the OSRI web site

(www.pwssc.gen.ak.us/osri/)

That document provides a comprehensive description of the extended group referenced in the Summary section.

It is also the source for the Investigator Qualifications for this project.

BUDGET

	mos	$/mo	cost ($K)
S Bodnar	2.5	7.2	18.00
V Patrick	0.2	8.5	1.70
programmers	1	7.1	7.10

(primary J. R. Allen; see also extended group listing)

computing support and telecommunications		0.37
telephone and FAX		0.50
media, materials		0.30
hardware: mass storage		1.80

travel

Cordova-Anchorage-Cordova	2	0.90

total direct	30.67
indirect rate 0.286	
indirect costs	8.77
total cost	39.44

Toxicity Syndrome of Environmentally Persistent Petroleum Hydrocarbons

Project Number:	~~New~~ 00571
Restoration Category:	Research
Proposer:	Center for Coastal Monitoring and Assessment, NOS
Lead Trustee Agency:	NOAA
Cooperating Agencies:	As appropriate
Alaska SeaLife Center:	No
Duration:	1st year -- 2-year project
Cost FY 00:	$137.4K
Cost FY 01:	$100K
Geographic Area:	Prince William Sound, lower Cook Inlet
Injured Resources:	Nearshore ecosystem; subtidal communities

ABSTRACT

This proposal is to determine direct chemical toxicity as well as genotoxicity on the same test organisms following exposure to fresh and weathered North Slope crude oil and to sediment from subtidal shorelines in Prince William Sound that still retain oil from the Exxon Valdez oil spill. The proposed study is predicated on increasing scientific evidence in recent years that links cytological damage, heritable mutations in the gene pool, and other genotoxic effects to adverse impacts on Darwinian fitness parameters. Impairment of these parameters, in turn, has individual or population level consequences. The study is directly pertinent to restoration of the nearshore ecosystem, particularly in the intertidal and subtidal regions, and for selected species for which recovery from the Exxon Valdez oil spill has been slow. The proposed study, utilizing a suite of newly developed toxicity bioassays and chemical measurements, offers a novel approach to examining acute as well as long-term injuries to natural resources from environmental contamination. The study results may provide a clue to widely disparate susceptibility, and hence recovery, of different species following exposure to petroleum hydrocarbons.

INTRODUCTION

Toxicity is defined as "the inherent potential or capacity of a substance to cause adverse effect(s) on living organisms; the effect(s) could be lethal or sub-lethal, direct or indirect" (Wells, Lee, and Blaise, 1998). However, and quite unfortunately, in the ecotoxicological literature a distinction is often made between direct chemical toxicity (as measured by LC50 or similar parameters) and genotoxicity (as measured by Ames assay, DNA damage, chromosomal aberrations, or other biomarkers). Certain polycyclic aromatic hydrocarbons (PAHs), such as napthlalene, are often considered "toxic" and not necessarily genotoxic, while others, such as perylene, are considered genotoxic and not necessarily "toxic" (Cerniglia and Heitkamp, 1989). In a relative sense, scientific data on the prevalence of genotoxicity from environmental contamination are much fewer and such studies have seldom been carried out in the field.

Sediment toxicity assessment studies in the aftermath of the Exxon Valdez oil spill either focused on the levels of petroleum hydrocarbon residues in sediment (Babcock et al., 1996) and in mussel tissues (Harris, et al., 1996), or bioassay based on direct chemical toxicity, for example, mortality in amphipods and oyster larvae (Wolfe, et al., 1996). Genotoxic aspects of contaminated sediment were not studied.

It is increasingly evident from the scientific literature that most toxicants cause both metabolic impairment (including death) and genetic damage. For example, it is known that the polycyclic aromatic hydrocarbons elicit DNA damage (adducts, strand breakage, etc.) but they also induce enzyme systems that are involved in biotransformation of contaminants. In turn, biotransformation may result in detoxification and elimination of the contaminant, but may also lead to the production of more reactive metabolites that can adversely affect a range of metabolic functions or be genotoxic (Canova, et al., 1998). Kurelic (1993) has described the genotoxic disease syndrome to include impairment of enzyme function, altered protein turnover, production of initiators of cytotoxic injuries, inhibition of growth, degenerative processes and atrophy in tissues and organs, decreased growth, faster aging, impairments of immunoresponse and reproduction, increased frequency of disease and neoplasia, impairment of survival and succession, and finally, elimination of species.

The need to study genetic damage from environmental contaminants and to examine its adverse effects on population size or gene pools was strongly endorsed at the "Napa Conference on Genetic and Molecular Ecotoxicology" sponsored by the National Institute of Environmental Health Sciences in 1993, and, more recently, at the "Bivalve Biomarker Workshop, sponsored by the National Ocean Service, NOAA, in 1998. The proceedings of the Napa Conference were published in 1994 (Environmental Health Perspectives 102 (supplement 12), 1994) and those of the NOAA workshop will be published in the journal "Biomarker" in 1999. Participants at the Napa Conference identified "restoration ecotoxicology" as a critical focal point of studies on chemical-induced genetic and epigenetic damage. Specifically, techniques for detecting genetic damage include: prevalence of DNA adducts, DNA unwinding and strand breakage, proliferation of

micronuclei, and c-K-ras oncogenes. Participants at these workshops also reiterated at both meetings that toxicity - including genotoxicity - studies be carried out on "model" or sentinel species for establishing the mechanistic basis and validation of diagnostic measures, and disclosing phylogenetic differences in resistance or susceptibility. Further, it was recognized that analytical techniques for such measurements are in a rapidly evolving state and that reliable tools are now available to examine the complex biological responses to environmental xenobiotics.

NEED FOR THE PROJECT

A. Statement of Problem

Persistence of spilled crude oil in Alaskan sub-Arctic areas was studied as part of the Outer Continental Shelf Environmental Assessment Program (OCSEAP) long before the Exxon Valdez oil spill. The studies were based on granulometric and hydraulic properties of the sediment (Hayes and Ruby, 1979), microbial activity in oiled sediment (Griffiths and Morita, 1980), and chemical measurements of the North Slope crude oil buried in coastal sediments over a 17-month period (Payne, et al., 1984). It was concluded that a substantial fraction of crude oil could remain buried in certain coastal areas for 10 years or more. A mass-balance analysis of the Exxon Valdez oil spill estimated that 13 percent of the spilled oil was buried in subtidal sediment as of Fall 1992 (Wolfe, et al., 1994). Based on a more recent analysis of data on hydrocarbon concentrations and estimates of biological injuries following major oil spills, the maximum oil spill vulnerability index for the Norwegian coastline implies widespread mortality of biota and a recovery time of more than 20 years (Lein, et al., 1992). Given these observations, it would seem reasonable to expect spilled oil from the tanker Exxon Valdez to have remained, albeit in small amounts, in certain coastal areas of Prince William Sound and Cook Inlet. However, it is not clear whether the impacted areas still pose significant toxicity to biota. This is an important factor in evaluating the recovery and restoration of the areas affected by the oil spill.

B. Rationale/Link to Restoration

Continued exposure to petroleum hydrocarbons, as well as other xenobiotic substances, can result in a myriad of toxic responses at individual and population levels. From an ecological perspective, loss of gametes due to cell death, embryo mortality, heritable mutations in the gene pool, and changes in gene expression ultimately affect Darwinian fitness parameters (Anderson and Wild, 1994; Depledge, 1996). Darwinian fitness parameters are construed to include: growth rates, timing of reproduction, number of offspring, and viability of offspring (Depledge, 1994). Adverse impacts on these parameters, whether from natural causes or anthropogenic, can reduce the size and recovery potential of fish and wildlife populations, particularly those in the sub-Arctic and Arctic regions. Individuals in such populations often operate at the brink of energy reserves and are noted for low fecundity. Thus it is not surprising to note that seabird

populations never fully recovered following an oil spill in the English Channel in 1907 from the schooner Thomas W. Ralston. Simulation modeling of avian energetic from an hypothetical oil spill in the eastern Bering Sea showed similar results: a 15% reduction in fecundity in thick-billed murre or a 35% reduction in fecundity in black-legged kittiwake would make the population recovery of these species entirely unlikely (Ford, et al., 1982).

Studies of genotoxicity, alteration of phenotypic characteristics, and implication of such changes at the population level have been carried out for a number of species, ranging from nematodes, polychaetes, sea urchins, fish, transgenic fish, and turtles (Hose and Puffer, 1983; Shugart, 1990; Anderson and Wild, 1994; Steinert et al., 1998; among others). Only a few of these studies were based on xenobiotic exposures in the field or performed complementary analysis of "direct chemical toxicity." This proposed study will concurrently examine both aspects of toxicity in relation to contaminant levels in the field. Toxicity tests will be based on amphipod mortality and impairment of sea urchin fertilization. Substantial data exist for both of these tests to determine minimum significant levels and, therefore, statistical power of the test results (Thursby, et al., 1997; Carr and Biedenbach, in press). Upon successful completion of this project, as we expect, additional species and life forms -- such as mussels, salmon smolts, and harbor seal -- may be added to this study in the second year.

C. Location

The proposed study areas are in Prince William Sound at locales that were heavily oiled after the Exxon Valdez oil spill and where subtidal or intertidal concentrations of comparable petroleum hydrocarbons were exceptionally high. In addition, an area off Kasitsna Bay (lower Cook Inlet) will be studied for comparative purposes.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

In recent years, sustainable development, environmental protection, and the inclusion of Native people in developmental decision-making have become policy priorities on national and international levels. The United States Arctic policy declares that the US should work to involve Arctic indigenous people in decisions which affect them. Internationally, the 1992 Rio Declaration on Environment and Development emphasizes the importance of satisfying human needs in the context of sustainable development. The Declaration states that nations should support the effective participation of Native people in the achievement of sustainable development, and notes the importance of traditional knowledge in environmental management.

NOAA has a long and creditable history of involving Alaska Natives and other groups in the management of natural resources and implementation of research and monitoring programs. During the formative phases of the Outer Continental Shelf Environmental Assessment Program, NOAA sought and received ideas and comments from other agencies and the State of Alaska (through liaison positions) and local user groups

(through a User Advisory Committee or Users Panel) on the scope and priorities of the program's activities and the adequacy of information that was being generated and disseminated to the public. The participation of Natives and other local residents was invaluable in the design and implementation of numerous studies, such as the Peard Bay Ecosystem Study, migratory pattern of anadromous fish in coastal waters, and identification of resources at risk from potential oil spills.

Over the years, NOAA staff have developed an unmatched level of communication and trust with the people and organizations in Alaska. We have explained the merits and potential benefits of our laboratory and field experiments (one of which involved release of water soluble fraction of crude oil in a small bay), described the results of scientific studies (including monitoring of contaminant residues in tissues of animals used for subsistence, and relative risks of radiation dosage from consumption of country foods), and have involved local people in dissemination of scientific results across communities. We anticipate this to continue through direct contact and communication and also through liaison and facilitator positions that have been established for this purpose by the Trustee Council.

PROJECT DESIGN

A. Objectives

The primary objective of this study is to characterize the selected study areas in terms of sediment toxicity and demonstrate the feasibility of concurrent measurements of "direct chemical toxicity" and genotoxicity in biota exposed to contaminated sediment. Special emphasis will be on the effects of petroleum hydrocarbons and polycyclic aromatic hydrocarbons (PAHs).

Specifically, the objectives are:

(1) Characterize study areas in terms of contaminant exposure and sediment toxicity as measured by amphipod mortality, impairment of sea urchin fertilization and larval development, and induction of the P450 enzyme system.
(2) Describe genotoxic response in exposed animals as measured by the type and frequency of DNA strand breakage, and in relationship with estimates of "direct chemical toxicity."
(3) Estimate the spatial extent and severity of sediment toxicity in the study area(s) and relate observed toxic response to levels of chemical contaminants.

B. Methods

All aspects of this proposed study will focus on the following null hypothesis: there is no difference between impacted and non-impacted sites in terms of sediment toxicity as measured by "direct chemical toxicity" and genotoxicity.

Even though the study is designed to evaluate toxicity of environmentally persistent petroleum hydrocarbons resulting from the Exxon Valdez oil spill, some laboratory work will be essential for establishing analytical procedures and to infer toxicity responses from exposures to different concentrations of fresh and weathered crude oil. The North Slope crude oil will be obtained from Alyeska Pipeline Service Company in Valdez, Alaska. Weathered oil will be obtained by mixing crude oil with sediment from one of the "clean" reference sites that have been used in NOAA's sediment toxicity assessment studies (Long, et al., 1996) and exposing the oil-sediment mixture under field conditions for 1 to 3 months (Anderson, et al., 1978; Payne, et al., 1984). Chemical analyses of petroleum hydrocarbons will be according to the methods that have been used in NOAA's National Status and Trends Program and the Exxon Valdez oil spill response studies (Short et al., 1996; NOAA 1998).

Field samples will be collected during summer 2000. Provisionally, we have identified Foul Bay and Herring Bay in Prince William Sound as test sites and Kasitsna Bay as a control site. These sites may be changed following discussion on their suitability in terms of severity of oiling and/or biological damage. All field collections will be based on a stratified random sampling design and processing of data will follow the guidelines recommended for such sampling (Heimbuch, et al., 1995).

A stainless steel Van Venn grab will be used to obtain a sufficient amount of sediment sample for chemical analyses and toxicity testing. The bulk of the sediment sample is used for the amphipod bioassays, since five replicates are required in the test protocol. Sea urchin fertilization and embryological development tests require sediment porewater for exposure that can be extracted in the laboratory ashore (Carr and Chapman, 1992). Tests for the Reporter Gene System bioassay require organic extract of sediment that is obtained in accordance with EPA Method 3550 (Johnson and Long, 1998).

The proposed toxicity tests are fairly standardized and have been used by NOAA in its ongoing study to determine the spatial extent of sediment toxicity in US coastal waters. To date, nearly 2000 sites have been sampled as part of the study. The large number of samples for each toxicity test has provided a wide range of data, descriptive statistics, and estimate of the probabilities of correctly rejecting the null hypothesis when it is not true, i.e., power of the test. Detailed testing procedures, data analysis methods, and statistical inference to determine minimum significant differences from controls for the proposed toxicity tests in this study have been described in the scientific literature. Key references are noted below:

Amphipod bioassay (ASTM, 1992; Thursby et al, 1997)

Sea urchin bioassays (Carr and Chapman, 1992; Carr and Biedenbach, 1998)
RGS bioassay (ASTM, 1997; Anderson, et al., in press)
DNA strand breakage "Comet assay" (Steinert, et al., 1998a; 1998b)

As noted, the proposed toxicity tests have been used to evaluate adverse biological effects of sediments following oil spills and in contaminated coastal waterways and embayments nationwide. The Comet assay technique has also been used to evaluate the combined effects of exposure to ultraviolet radiation and PAHs. However, we are not aware of these tests being used in tandem to examine both chemical toxicity and genotoxicity in the same test organisms.

Given that whole organisms as well as both somatic and reproductive cells will be examined for genotoxicity in the proposed study, it should be noted that cells from highly metabolic tissues, such as those developing embryos, or those from tissues with low DNA repair capability, such as the brain tissues, have high background levels of single strand breakage. In such cases, particular emphasis will be placed on the frequency of double strand breakage (DSB). Detection of double strand breakage is comparatively much less sensitive, it is sensitive enough to detect 200 DSBs per cell (McKelvey-Martin, et al., 1993). These aspects of the Comet assay, as well as the influence of apoptosis, have been examined (Steinert, 1996). Current methods, including computer-aided recognition and enumeration, offer consistent measures of different aspects of cytotoxicity and provide data that are amenable to statistical analyses (Steinert, et al., 1998a).

C. Cooperating Agencies, Contracts, and Other Agency Assistance

As part of its National Status and Trends Program, NOAA/CCMA has carried out cooperative and contracted research activities with other Federal agencies, state and local agencies, academic and research institutions, and the private industry. A number of analyses performed under the program are either continually evolving (and improving) or they require unique capabilities (or a proprietary product). Our approach for collaborative and contracted activities ensures both availability of the highest level of expertise and cost effectiveness. We anticipate this approach to continue under this project.

Although no decision has been made for this project, we anticipate collaboration and technical assistance from individuals or laboratories of the Department of the Navy, US Department of the Interior, other NOAA laboratories, universities, and the private industry.

SCHEDULE

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

November 30:	Complete contracting procedures
December 15:	Initiate laboratory analyses; plan field work

January 18-28:	Attend Annual Restoration Workshop
March 1:	Arrange for field operations
April 15:	Outreach and consultations
June 15:	Complete field sampling
August 15:	Complete sample analyses
September 15:	Produce draft report

B. Project Milestones and Endpoints

The three stated objectives of the study will be accomplished and the results reported in the draft report due on September 15.

C. Completion Date

The proposed pilot study will be completed in one year. The second of the study will be initiated in FY 2001 and completed in that fiscal year.

PUBLICATIONS AND REPORTS

The principal means of communicating the data and results from this study will be through publications in scientific journals. Consistent with NOAA's policy of dissemination of scientific data and information to the public and decision-makers, data and information products from this study will be published as a Technical Memorandum, posted on a website, and presented as a special, non-technical report for the public at large. Since the methods proposed for this study are newly developed and, in certain aspects, define state-of-the-art, CCMA will take an active role in technology transfer and training for interested organizations or individuals.

PROFESSIONAL CONFERENCES

NOAA encourages its scientists and other professionals to take an active role in presenting their findings at conferences, workshops, and symposia. Results from this study will be presented at scientific meetings sponsored by the Trustee Council as well as at other professional meetings.

NORMAL AGENCY MANAGEMENT

CCMA conducts or sponsors a wide variety of studies in the coastal regions of the United States, most of them focused on coastal water quality problems and solutions. They include coastal monitoring as NOAA's Mussel Watch project; assessment of biological effects associated with chemical contaminants, radionuclides and other sources of environmental degradation; historic trends in coastal contamination; estuarine eutrophication; and harmful algal blooms.

The proposed study, dealing with restoration of coastal ecosystems and species following the Exxon Valdez oil spill, is not part of environmental research, assessment and monitoring studies that are normally undertaken by CCMA. However, the CCMA expertise and collaborative work history with national and international experts in the field of ecotoxicology offer an excellent means to examine the status and recovery of injured resources in Prince William Sound and adjacent regions of the Gulf of Alaska.

COORDINATION AND INTEGRATION WITH THE RESTORATION EFFORT

CCMA staff are well aware of the scope and variety of studies that have been undertaken following the Exxon Valdez oil spill. These studies focused on the response to the oil spill, remediation of affected areas, and restoration of the injured resources. CCMA scientists and other NOAA staff have participated in these studies since 1989. In addition, CCMA staff were involved in developing a very large data base on the physical environment and biological resources of the Gulf of Alaska, and more specifically for Port Valdez in the context of petroleum development and related industrial operations. These efforts required extensive coordination with scientists from other agencies, academic and research institutions, non-governmental organizations, and the public at large.

Implementation of the proposed study, particularly selection of field sampling sites during the first phase of the study and identification of target species during the second phase of the study would require consultation with other scientists and resource managers who are involved in the restoration program. It is anticipated that at least some of the field work will be done collaboratively with other field parties to reduce the overall cost of logistics and improve follow-up consultations on synthesis of study results.

PROPOSED PRINCIPAL INVESTIGATOR

Dr. M. Jawed Hameedi

Dr. Hameedi is the proposed Principal Investigator for this study. As such he will be primary contact with the Trustee Council for this project. He will be responsible for all aspects of research coordination, field and laboratory analyses, information synthesis, and reporting.

Dr. Jawed Hameedi is a Team Leader in the Center of Coastal Monitoring and Assessment. He is responsible for developing and implementing a program of environmental studies to determine the biological effects of contamination and other sources of environmental degradation in coastal waters. These studies focus on sediment toxicity assessment, application of biomarkers, development of sediment quality guidelines, evaluation of in situ changes in the benthic biological communities, and assessment of ecological and human health risks posed by radionuclides in the coastal environment and in species used for subsistence in the United States Arctic. Since 1989, he has participated in the development of the scientific content of the international Arctic Monitoring and Assessment Program (AMAP) and is a co-author of an Arctic-wide assessment of petroleum pollution.

Prior to assuming his current position, he served as deputy director and director of the Outer Continental Shelf Environmental Assessment Program during the period 1981-92. This multi-year (1974-92) and inter-disciplinary program was the largest marine environmental research program in Alaska. The program produced over 4,000 reports, including inter-disciplinary synthesis reports, covering all aspects of coastal and marine sciences. In particular, the program focused on the movement and fate of spilled oil, determination of the biological effects of petroleum pollution, ecological characterization of coastal areas and seas of Alaska, development of monitoring strategies, and analysis of environmental consequences of petroleum development. During his tenure in Alaska, he also served as agency representative to the Regional Response Team, and managed the operations of NOAA's Kasitsna Bay Laboratory.

Dr. Hameedi is an internationally recognized expert on matters related to petroleum development, environmental monitoring and assessment in the coastal zone, and contamination issues in the Arctic. He has published over 70 scientific publications, including research papers, book chapters, and special reports. He has served on numerous work groups, research committees, and panels on environmental research and monitoring. While in Alaska, he held a affiliate Associate Professor position at the University of Alaska Fairbanks.

Dr. Andrew Robertson

Dr. Robertson will be the Project Manager for this study and will have the agency responsibility for personnel, fiscal and administrative resources required by this study.

Dr. Robertson is Director of the Center for Coastal Monitoring and Assessment (CCMA), National Centers for Coastal Ocean Science (NCCOS), National Ocean Service, NOAA. He directs a variety of coastal environmental research, assessment and monitoring studies, including the National Status and Trends Program which is only nation-wide program of marine pollution monitoring and assessment for U.S. coastal waters, including the Great Lakes. The program determines the levels and biological effects of contaminants and develops assessment reports. It is closely coordinated with other federal agencies, such as U.S. Environmental Protection Agency, and coastal states. Dr. Robertson has served as a scientific expert at national and international workshops on topics related to marine environmental quality (coastal pollution, ocean dumping, and non-point sources of pollution), ecosystem health, and petroleum pollution in the Arctic. In addition, he is a member of several working groups and committees to develop a more effective and integrated environmental monitoring program in the United States.

OTHER KEY PERSONNEL

The study team will include a cadre of internationally recognized scientific experts, both within and outside NOAA. These individuals have worked together on a number or projects. However, in deference to provisions of the Economy Act, the non-NOAA participants are not being formally identified as key personnel at this time. These individuals are:
Dr. Jack Anderson -- P450 RGS assay
Dr. Scott Carr -- Sea urchin fertilization tests
Dr. Jim Payne -- Crude oil weathering
Mr. Scott Steinert -- Genotoxicity

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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		$12.2
Contractual		$117.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$129.2
General Administration		$8.2
Project Total	$0.0	$137.4
Full-time Equivalents (FTE)		0.3
Other Resources		$42.9

LONG RANGE FUNDING REQUIREMENTS

Dollar amounts are shown in thousands of dollars.

		Estimated FY 2001	Estimated FY 2002		
		$100.0			
		$42.9			

Comments:

NOAA will assume personnel costs for this project. The estimated personnel cost for the four scientists leveraged by this project is $34.4. In addition, NOAA will assume all costs associated with use of the Kasitsna Bay laboratory, located on the shores of Kachemak Bay, NOAA's newest National Estuarine Research Reserve. Costs associated with the use of Kasitsna Bay laboratory are estimated at $1.5. NOAA will also assume equipment costs of approximately $7.0 for grab samples.

Total leveraged funding from NOAA for this project is estimated at $42.9.

FY00

Prepared: 4/15/1999

Project Number: 00571
Project Title: Toxicity Syndrome of Environmentally Persistent Petroleum Hydrocarbons
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

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
Dr. Andrew Robertson	Director, Center for Coastal Monitoring an	SES	0.5	0.0	0.0	0.0
Dr. Jawed Hameedi	Team Leader, Biological Effects, CCMA	GS-15	1.5	0.0	0.0	0.0
Dr. Nathalie Valette-Silver	Physical Scientist, CCMA	GS-14	1.0	0.0	0.0	0.0
Ms. Michelle Harmon	Physical Scientist, CCMA	GS-12	1.0	0.0	0.0	0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Subtotal			4.0	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
To Anchorage, Homer, and Seward for field work.	1.2	3	7	0.2	5.0
To Anchorage for Annual Restoration Workshop.	0.8	1	4	0.2	1.6
To Anchorage for Technical Review.	0.8	1	4	0.2	1.6
To TBD for synthesis of research results by contractors.	1.0	3	5	0.2	4.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$12.2

FY00

Prepared: 4/15/1999

Project Number:
Project Title: Toxicity Syndrome of Environmentally Persistent Petroleum Hydrocarbons
Agency: NOAA

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
Chemical analyses at $1.2/sample for 30 samples.	36.0
P450 RGS bioassay at $.2/sample for 30 samples.	6.0
Comet assay at $.6/sample for 30 samples.	18.0
Amphipod mortality at $.4/sample for 30 samples.	12.0
Sea urchin tests at $.5/sample for 30 samples.	15.0
Boat charter and logistics.	7.0
Shipment of samples.	2.0
Information synthesis of chemical and biological samples by contracted laboratories.	12.0
Editorial services including page charges and reprints.	9.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$117.0

Commodities Costs:	Proposed
Description	FY 2000
Commodities Total	$0.0

FY00

Prepared: 4/15/1999

Project Number:
Project Title: Toxicity Syndrome of Environmentally Persistent Petroleum Hydrocarbons
Agency: NOAA

FORM 3B
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
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

FY00

Project Number:
Project Title: Toxicity Syndrome of Environmentally Persistent Petroleum Hydrocarbons
Agency: NOAA

FORM 3B
Equipment
DETAIL

Prepared: 4/15/1999

RELATIONSHIP BETWEEN OIL EXPOSURE AND REPRODUCTIVE FUNCTION IN DOLLY VARDEN *(SALVELINUS MALMA)*

Project Number:	~~New project~~ 00576
Restoration Agency:	Research
Principle Investigator:	Tracy Collier, Ph.D., Environmental Conservation Division, Northwest Fisheries Science Center, National Marine Fisheries
Co-investigator:	Lyndal L. Johnson, Environmental Conservation Division, Northwest Fisheries Science Center, National Marine Fisheries
Co-investigator:	Sean Y. Sol, Environmental Conservation Division, Northwest Fisheries Science Center, National Marine Fisheries
Lead Trustee Agency:	NOAA
Cooperating Agencies:	none
Alaska SeaLife Center	yes
Duration:	1st year, 1-year project
Cost FY00:	82K
Geographic Area:	Prince William Sound, Kenai Peninsula
Injured Resource/Service:	Dolly varden

ABSTRACT

Field studies conducted following the *Exxon Valdez* oil spill showed that exposure to oil reduced reproductive function in female dolly varden *(Salvelinus malma)*. A significant negative relationship was found between oil exposure and plasma reproductive steroid (estradiol-17β) concentration. Gonadosomatic index (GSI) and gonadotropin I (GTH-I) concentration also tended to decline as exposure levels increased but the relationships were not significant. However, because of the variability due to factors such as fish size, age, and sampling time. it was difficult to determine the threshold exposure level associated with reproductive impacts in dolly varden, based on the field survey. Moreover, there has been limited followup of reproductive function in this species following the spill to determine whether Prince William Sound populations have achieved full recovery. We propose to conduct a controlled laboratory experiment to obtain more detailed information on dose response relationships between exposure to crude oil and reproductive endpoints in dolly varden. Additionally, dolly varden will be collected previously sampled impacted and non-impacted areas in Alaska to determine their recovery from the oil-spill exposure, both in terms of actual exposure as well as current reproductive function. The data derived from this study may be especially relevant in view of recent research suggesting that low-level exposure to oil-derived PAHs may be associated with reduced return rates in other salmonid species in Prince William Sound.

INTRODUCTION

Exposure to petroleum and its components can potentially damage fishery resources in a number of ways, including reducing the reproductive rates of fish stocks (National Research Council 1985). Several laboratory studies have documented oil-related declines in reproductive endpoints in marine teleosts. The types of effects observed include alterations in levels of reproductive hormones, inhibited gonadal development, and reduced egg and larval viability (Johnson et al. 1995; Truscott et al. 1992; Idler et al. 1995; Thomas and Budiantara 1995).

Field studies conducted following the *Exxon Valdez* oil spill (EVOS) indicated that dolly varden *(Salvelinus malma)* collected from oil-impacted areas had high concentrations of metabolites of aromatic compounds in bile (Collier et al. 1993; 1996), particularly metabolites fluorescing at the same wavelengths as naphthalene (NPH) and phenanthrene (PHN), two major components of Prudhoe Bay crude oil (PBCO) (Krahn et al. 1992). In 1990, we initiated an investigation of to look at the effect of oil exposure on reproductive endpoints in gravid female dolly varden. Plasma estradiol-17β (E2), gonadotropin-I (GTH-I), and gonadosomatic index (GSI) were measured in association with concentrations of metabolites of aromatic compounds in bile, an index of oil exposure. The reproductive hormone, E2, triggers vitellogenesis in female teleosts, and is an effective indicator of the initiation of gonadal development (Ng and Idler 1983). GTH-I is the primary pituitary hormone controlling gametogenesis in teleosts (Swanson et al. 1989). Decreases in these hormone levels presumably interfere with gonadal development or disrupt the hormonal signal for final maturation and spawning (Casillas et al. 1991; Johnson et al. 1988; Swanson et al. 1989). GSI provides an anatomical index of gonadal maturation.

Oil exposure assessment studies with dolly varden (Collier et al. 1993, 1996) showed that levels of fluorescent aromatic compounds (FACs) in bile were highest immediately after the spill. Although a significant decline in biliary FAC-PHN levels in the year following the spill was observed, FAC-NPH levels remained elevated. In a survey of reproductive function in dolly varden which we conducted the year following the spill (Sol et al. in review), we observed a significant negative relationship between biliary FACs and plasma E2 concentrations. Both GSI and GTH-I also tended to decline with increasing oil exposure, although the relationships were not statistically significant. The reproductive endpoints in fish showed a great deal of variability at low to moderate FAC levels, and included both relatively high and relatively low values. At higher FAC levels, however, values for reproductive endpoints were uniformly low. The regression relationship derived from dolly varden sampled in 1990 was used to estimate likely plasma E2 concentrations of dolly varden sampled in 1989. Even though fewer number of fish were sampled in 1989 compared to 1990, a higher number of fish sampled in 1989 had exposure levels in the range where predicted plasma E2 concentrations were consistently low.

Although the field study suggests that exposure to oil may suppress reproductive endpoints in dolly varden, a controlled laboratory exposure study is needed to confirm these findings, and to provide additional information on the effects of lower level oil exposure on reproductive function in dolly varden. Moreover, additional field data is needed to assess both current oil exposure and reproductive status of dolly varden in Prince William Sound. This information is particularly relevant to the recovery of dolly varden stocks in view of recent research indicating that low level oil exposure may be associated with reduced return rates for pink salmon and other salmonid species in Prince William Sound (Heintz et al. 1999).

NEED FOR THE PROJECT

A. Statement of Problem

The levels of oil exposure in dolly varden sampled after the EVOS were some of the highest of any fish sampled in 1989 (Collier et al. 1993, 1996). Even a year after the spill, exposure appeared to be high enough to affect levels of reproductive steroids in dolly varden, as a significant negative relationship was observed between FACs and plasma E2 concentrations. The importance of steroids in regulating the reproductive cycle in vertebrates, including fish, is well established (Wallace, 1985), and any changes in their production or metabolism could potentially disrupt the normal reproductive cycle. However, we have only limited data on ovarian lesions associated with depressed plasma E2 concentrations in dolly varden. Also, the field data do not provide definitive information on the dose/response relationship between oil exposure and alterations in E2, GSI, or GTH I, especially at lower exposure levels, because of the inherent variability associated with field sampling. Perhaps most important, no follow-up information is available on the long-term effects of oil exposure on the reproductive health of dolly varden, although this is one of the species whose recovery is designated uncertain by the EVOS Trustee Council.

B. Rationale/Link to Restoration

Although the field study suggested that exposure to oil may suppress normal reproductive development in dolly varden, a controlled laboratory experiment is needed to confirm the findings. This study will also provide information on the oil exposure/reproductive effect relationship on dolly varden char, and will allow us to more accurate quantify the threshold levels of exposure which are associated with suppressed plasma E2 levels and other types of reproductive injury in this species. Additionally, dolly varden will be collected from previously sampled impacted and non-impacted areas in Alaska to determine their recovery from the oil-spill exposure. The information obtained from the field and laboratory study will improve our assessment of the likely degree of injury to dolly varden during the EVOS, as well as the degree of recovery in the years following the spill.

C. Location

The project will be undertaken in June of 2000, with the use of Alaska SeaLife Center, Seward, Alaska. Dolly varden will be collected from oil spill impacted and non-impacted areas of Prince William Sound, Alaska. Proposed study sites include Sleepy Bay, Snug Harbor, Squirrel Bay and Tonsina Bay, which were all heavily oiled following the spill, and Olson Bay, a relatively unimpacted reference area. A portion of the fish caught will be necropsied aboard the fishing vessel for assessment of baseline exposure and reproductive indices. Additional fish will collected from Olsen Bay and transported to the Alaska SeaLife Center for the laboratory

exposure study. All samples will be shipped to Northwest Fisheries Science Center, Seattle, Washington, for chemical and biological analyses.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Results will be posted on the Northwest Fisheries Science Center website where the public and members of the local community can easily access the information.
Fishing operations will be conducted with the assistance of Alaska SeaLife Center, and commercial fishermen.

PROJECT DESIGN

A Objectives

The specific objectives of this investigation are:

1. To determine the relationship between oil exposure and selected indicators of reproductive function in female dolly varden in a controlled laboratory settings;
2. To compare the relationships between oil exposure and reproductive endpoints derived from the laboratory study with the results of the previously conducted field study to more accurately assess the threshold exposure levels associated with reproduction injury in dolly varden following the EVOS;
3. To revisit oil spill impacted areas previously sampled to evaluate the extent of the recovery in resident dolly varden populations, in terms of both current oil exposure and reproductive function.

B. Methods

1. Fish and sample collection. Vitellogenic female dolly varden will be collected from Olson Bay, Sleepy Bay, Snug Harbor, Squirrel Bay, and Tonsina Bay in Prince William Sound in June of 2000. These sites were previous sampled in 1989 and 1990 following the EVOS (Collier et al. 1993; 1996). Sleepy Bay, Snug Harbor, Squirrel Bay and Tonsina Bay were all heavily oiled following the spill, while Olson Bay was a relatively unimpacted reference area. Fish will be captured by either beach seine or gill net set perpendicular to the shore, and kept in holding tanks aboard the research vessel following capture. Approximately 30 fish per site will be necropsied aboard the fishing vessel for baseline exposure and reproductive indices. Fish will be measured and weighed, and a 1 ml blood sample will be taken from the caudal vein with a heparinized syringe for determination of plasma levels of E2. Blood samples will be centrifuged at 800 x g and the resultant plasma samples stored at -20^{o}C. The fish will then be sacrificed by severing the spinal chord. Ovaries will be excised and weighed, and ovarian tissue samples will be preserved in Davidson's fixative (Mahoney, 1973) for histological examination. The remaining

abdominal contents will then removed and the gutted carcass weighed for determination of condition index. Bile will be collected and stored at -80°C for determination of biliary FACs.

2. Laboratory exposure study.

Dolly varden for the laboratory exposure experiment will be collected from the Olson Bay reference site and transported to the Alaska SeaLife Center. Weight and total length of fish will be determined and fish will be tagged for identification. A 1 ml blood sample will be taken from the caudal vein with a heparinized syringe for determination of initial plasma levels E2. Dolly varden will be injected intramuscularly with a mixture of Prudhoe Bay crude oil (PBCO) and acetone:Emulphor 620 (1:1, v/v) carrier at doses of 0.001, 0.005, 0.01, 0.05, 0.1, 0.2, 0.5, and 1.0 ml oil/kg body weight. Final injection volume will be held constant at 1.0 ml/kg body weight. A control group injected with 1.0 ml of the carrier per kg body weight will serve as control. Each treatment group will contain a minimum of 5 fish, with 10-15 fish as the proposed target number if possible.

Following the initial treatment, fish will be held for 3 days and reinjected on the fourth day according to the same treatment protocol. On Day 7, the fish from all treatment groups will be necropsied and samples will be collected for assessment of exposure and reproductive function as described in the field sampling section. Additionally, ovarian tissue fragments (approximately 2-3 mm in diameter; 0.05 g wet weight) will be placed in Hank's balanced salt solution (Moon et al. 1985), and stored on ice for subsequent for determination of E2 production *in vitro* (Yaron and Barton, 1985; Kagawa et al. 1982).

3. Analyses of Tissues and Fluids.

Ovary tissue collected for histology will be embedded in paraffin, sectioned, stained with hematoxylin and eosin (Luna, 1968) and examined microscopically to assess the stage of development. The ovarian tissue sections will also be examined for follicular atresia and inflammatory lesions associated with oocyte resorption, including lymphoid or macrophage infiltrates.

Levels of fluorescent aromatic compounds (FACs) in bile will be measured by high performance liquid chromatography (HPLC) according to the method of Krahn et al. (1985), which provides a semi-quantitative determination of the metabolites of polycyclic aromatic compounds, including PAHs (Krahn et al. 1992). The HPLC eluants will be monitored using two fluorescence detectors (Perkin Elmer model 40) connected in series, whose excitation/emission wavelengths will be set to measure fluorescent metabolites of naphthalene and phenanthrene, the predominant components of the aromatic fraction of crude oil.(Krahn et al. 1992). Concentrations of biliary FACs will be reported as equivalents of known concentrations of PHN or NPH standards on the basis of biliary protein because studies (Collier and Varanasi, 1991) have shown that such normalization can partially account for variation in FAC levels associated with the feeding status of sampled fish. Concentrations of biliary protein were determined by the method of Lowry et al. (1951) using bovine serum albumin (Sigma) as the standard.

Plasma E2 levels will be determined by radioimmunoassay (RIA) as described by Sower and Schreck (1982). *In vitro* ovarian E2 production will be determined by the methods of Yaron and Barton (1980) and Kagawa et al. (1982).

4. Statistical analyses. Differences in concentrations of biliary FACs, plasma E2 and *in vitro* E2 production between treatment groups or sites will be evaluated by analysis of variance (ANOVA) followed by Dunnett's multiple range test (Dowdy and Wearden, 1991). The relationships between biliary FAC levels and E2 following treatment will be examined by using appropriate non-parametric or parametric regression techniques. Between-group differences in ovarian lesion prevalence will be evaluated using the G-statistic (Sokal and Rohlf, 1981). Statistical significance will be set at $\alpha = 0.05$.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

NOAA/ECD (Collier/Johnson/Sol): Perform study design and execution, sample analyses, interpretation, conduct statistical analyses, aid in report preparation, write peer-reviewed manuscript.
Alaska SeaLife Center: Provide facility for and assistance with the laboratory injection study.
Commercial Fisherman/vessel: Provide local knowledge of dolly varden populations and appropriate fishing techniques.

SCHEDULE

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

June 1-20:	Fish and sample collection
June 30:	Complete laboratory injection study
Sept 30:	Complete sample analyses statistical analyses of the data

Project Milestones and Endpoints (October 1, 1999 to September 30, 2001)

April 15:	Submit annual report
September 30:	Submit manuscript to peer-reviewed journal

C. Completion Date

Project will be completed by September 2001.

PUBLICATIONS AND REPORTS

An annual report will be submitted to the Council by 15 April 2001. Manuscript(s) resulting from this research will be submitted to peer-reviewed journals by September 2001.

PROFESSIONAL CONFERENCES

The presentation of project results will be presented at numerous scientific conferences to include: .

NORMAL AGENCY MANAGEMENT

The National Marine Fisheries (NWFSC/ECD) has already provided funding for the studies that provide the background information for this project. The ECD has sufficient funds to partially cover labor costs associated with the proposed field and laboratory studies, which will be provided as in kind support for the project. However, additional funds, primarily to cover the cost of operations and supplies, are needed to carry out this work.

PROPOSED PRINCIPAL INVESTIGATOR

Dr. Tracy Collier
NOAA/NMFS/NWFSC/ECD
2725 Montlake Boulevard East
Seattle, WA 98112
Phone: (206) 860-3312
FAX: (206) 860-3335
Email: Tracy.Collier@noaa.gov

OTHER KEY PERSONNEL

Lyndal L. Johnson
Environmental Conservation Division
Northwest Fisheries Science Center
National Marine Fisheries Service
Seattle, Washington
Task: Perform fishing operations, analyses of samples, interpretation, conduct statistical analyses, aid in report preparation, write peer-reviewed manuscript.

Sean Y. Sol
Environmental Conservation Division
Northwest Fisheries Science Center
National Marine Fisheries Service
Seattle, Washington
Task: Perform fishing operations, analyses of samples, interpretation, conduct statistical analyses, aid in report preparation, write peer-reviewed manuscript.

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CURRICULUM VITAE **TRACY K. COLLIER**

Education

University of Washington, Seattle, WA	- B.S.	1976	Fisheries
University of Washington, Seattle, WA	- M.S.	1978	Fisheries
University of Washington, Seattle, WA	- Ph.D.	1988	Fisheries

Research and Professional Experience

1994-present	**Program Manager**, Ecotoxicology Program of the Environmental Conservation Division (ECD), NMFS
1996-1997	**Principal Investigator** on studies to determine injury to fishery resources in Rhode Island salt ponds following the *North Cape* oil spill.
1996-1998	**Principal Investigator** on study funded by NMFS Restoration Center to determine habitat utilization by groundfish assemblages following habitat remediation
1995-present	**Habitat Science Coordinator**, NWFSC
1994-1996	**Principal Investigator** on study funded by NMFS and USEPA to determine efficacy of subtidal remediation
1994-present	**Research Advisor** for National Research Council Postdoctoral Research Associate Program
1993-present	**Division Coordinator** for Natural Resource Damage Assessment and Restoration Science
1992-1996	**Research Group Leader**, Biochemical Pathology Group of the ECD,
NMFS 1992-present	**Supervisory Research Chemist**, ECD, NMFS
1992-1994	**Assistant Branch Manager**, Ecotoxicology Branch of the ECD, NMFS
1990-1994	**Division Coordinator** of efforts involving Natural Resources Damage/Restoration after the EXXON Valdez oil spill
1993	**Visiting Scientist**, Laboratory of Marine Molecular Biology, Bergen, Norway
1991	**Chief Scientist**, Natural Resources Damage Assessment survey of Prince William Sound
1988-1992	**Assistant Task Manager**, Biochemistry Task of the ECD, NMFS
1978-1992	**Research Chemist**, ECD, NMFS
1976-1978	**Fishery Biologist**, ECD, NMFS
1972-1976	**Biological Aid/Physical Science Technician,** ECD, NMFS

Professional Activities

1996-present	Essential Fish Habitat Team, National Marine Fisheries Service
1996-present	Technical Advisory Panel to Cook Inlet Keeper Program
1996-present	Controlling Toxic Inputs Working Group of Puget Sound/Georgia Basin Transboundary Task Force
1996-1998	Salt Pond Injury Technical Working Group for assessment of injury to natural resources following the North Cape Oil Spill
1995-1997	Management Committee for Puget Sound Estuary Program
1994-present	Environmental Monitoring Committee, Cook Inlet Regional Citizens Advisory Council

1994-1996	Scientific Advisory Committee, Marine Science Society of the Pacific Northwest
1993-1994	Chair, Technical Advisory Panel for Damage Assessment Regulations Team of NOAA

Scientific Publications- 70+ total, selected recent examples given below

Peck-Miller, K.A., J.E. Stein, and **T.K. Collier**. 1999. Complete cDNA sequence of the K-ras proto-oncogene in liver of English sole (*Pleuronectes vetulus*): A wild fish species model of environmental carcinogen induced hepatic neoplasia. Molec. Carcinogenesis. (in press). Gallagher, E.P, K. Sheehy, P. Janssen, D.L. Eaton, and **T.K. Collier**. 1999. Isolation and cloning of homologous glutathione S-transferase cDNAs from English sole and starry flounder. Aquat. Toxicol. (in press).

Reichert, W.L., M.S. Myers, K. Peck-Miller, B. French, B.F. Anulacion, **T.K. Collier**, J.E. Stein and U. Varanasi. (1998). Genotoxic events in marine fish from exposure to complex mixtures of environmental contaminants. Reviews in Mutation Research 411:215-225.

Collier, T.K., L.L. Johnson, C.M. Stehr, M.S. Myers, and J.E. Stein. (1998). A comprehensive assessment of the impacts of contaminants on fish from an urban waterway. Mar. Environ. Res. 46:243-247.

Horness, B.H., D.P. Lomax, L.L. Johnson, M.S. Myers, S.M. Pierce, and **T.K. Collier**. (1998). Use of hockey stick regression for determination of sediment quality thresholds: aromatic hydrocarbons versus liver lesions in a benthic fish species. Environ. Toxicol. Chem. 17:872-882.

Eufemia, N.A., **T.K. Collier**, J.E. Stein, D.E. Watson, and R.T. Di Giulio. (1997). Biochemical responses to sediment-associated contaminants in brown bullhead (*Ameriurus nebulosus*) from the Niagara River ecosystem. *Ecotoxicology* 5:1-22.

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

McCain, B.B., D.W. Brown, T. Hom, M.S. Myers, S.M. Pierce, **T.K. Collier**, J.E. Stein, S.-L. Chan, and U. Varanasi. (1996). Chemical contaminant exposure and effects in four fish species from Tampa Bay. *Estuaries* 19:86-104.

Stein, J.E., T.Hom, **T.K. Collier**, D.W. Brown, and U. Varanasi. (1995). Contaminant exposure and biochemical effects in outmigrant juvenile Chinook salmon from urban and non-urban estuaries of Puget Sound, WA. *Environ. Toxicol. Chem.* 14:1019-1029.

Collier, T.K., B. F. Anulacion, J. E. Stein, A. Goksøyr, and U. Varanasi. (1995). A field evaluation of cytochrome P4501A as a biomarker of contaminant exposure in three species of flatfish. *Environ. Toxicol. Chem.* 14:154-162.

Husøy, A.-M., M.S. Myers, M.J. Willis, **T.K. Collier**, M. Celander, and A. Goksøyr. (1994). Immunohistochemical localization of CYP1A and CYP3A-like isozymes in hepatic and extrahepatic tissues of Atlantic cod (*Gadus morhua* L.), a marine fish. *Toxicol. Appl. Pharmacol.* 129:294-308.

Curriculum Vitae — Lyndal L. Johnson

Education

University of Washington, Seattle, WA	Ph.D. candidate	1996-present	Fisheries
University of Washington, Seattle, WA	M.S.	1996	Fisheries
University of Washington, Seattle, WA	graduate study, no degree	1978-80	Botany
Western Wash. Univ., Bellingham, WA	B.S.	1976	Biology

Research and Professional Experience

1996-present	Team Leader, Reproductive and Development Toxicology Team, ECD, NWFSC, NMFS
1991-1996	Research Group Leader, Reproductive and Populations Effects Group of the ECD, NWFSC, NMFS
1989-1991	Division Coordinator of Reproductive Effects projects, ECD, NWFSC, NMFS
1988-1991	Sub-Task Coordinator of data management activities within Histopathology Research Group, ECD, NWFSC, NMFS
1988-present	Zoologist, ECD, NWFSC, NMFS
1984-1987	Microbiology Technician, Environmental Conservation Division (ECD) Northwest Fisheries Science Center (NWFSC), National Marine Fisheries Service (NMFS)
1982-1984	Laboratory Technician, Dept. of Biol. Structure, Univ. of Wash.
1980	Teaching Assistant, Dept. of Botany, Univ. of Wash.
1977	Biolological Technician, Dept. of Forest Resources, Univ. of Wash.
1974-1977	Biological Technician, U.S. Forest Service, Olympic National Forest, WA

Professional Activities

Participant, Environment Canada Environmental Effect Monitoring Program Review Panel, Toronto, Canada, July 1994

Participant, endocrine disruptor workship sponsored by EPA, Raleigh, NC. April 1995.

Participant, endocrine disruptor workshop to develop national strategy for research on ecological effects of endocrine disruptors. Duluth, MN, June 1995.

Session Co-chair, Environmental Influences on Reproduction Session, Fifth International Symposium on the Reproductive Physiology of Fish, Austin, TX, July 1995

Habitat Loss Working Group of Puget Sound/Georgia Basin Transboundary Task Force (1996-present)

Protect Marine Life Working Group of Puget Sound/Georgia Basin Transboundary Task Force (1997-present)

Graduate Advisory Committee, Leslie Kubin, Western Washington Univ.1994-1997

Participant, EPA endocrine disruptor research grant peer review panel, Washington, DC. May 1997

Selected Publications

Johnson, L., Casillas, E., Collier, T., McCain, B. and Varanasi, U. 1988. Contaminant effects on ovarian development in English sole *(Parophrys vetulus)* from Puget Sound, Washington. Can. J. Fish. Aquat Sci. 45:2133-2146.

Johnson, L., Casillas, E., Myers, M., Rhodes, L. and Olson, O.P. 1991. Patterns of oocyte development and related changes in plasma estradiol 17β, vitellogenin, and plasma chemistry in English sole *(Parophrys vetulus)*. J. Exp. Mar. Biol. Ecol. 152:161-185.

Johnson, L., and Casillas, E. 1991. The use of plasma parameters to predict ovarian maturation stage in English sole *(Parophrys vetulus)*. J. Exp. Mar. Biol. Ecol. 151:257-270.

Casillas, E., Misitano, D., **Johnson, L.**, Rhodes, L., McCain, B. and Varanasi, U. 1991. Spawning and reproductive success of female English sole *(Parophrys vetulus)* from urban and non-urban sites of Puget Sound, Washington. Mar. Env. Res. 31:99-122.

Johnson, L.L., E. Casillas, S. Sol, T. Collier, J. Stein, and U. Varanasi. 1993. Contaminant effects on reproductive success in selected benthic fish species. Mar. Env. Res. 35:165-170.

Johnson, L. L., J. E. Stein., T. K. Collier, E. Casillas, and U. Varanasi. 1994. Indicators of reproductive development in prespawning female winter flounder *(Pleuronectes americanus)* from urban and nonurban estuaries in the northeast United States. Sci. Total Environ. 141:241-260.

Johnson, L. L. and J. T. Landahl. 1994. Chemical contaminants, liver disease, and mortality rates in English sole *(Pleuronectes vetulus)*. Ecological Applications 14:59-68

Johnson, L. L., J. E. Stein, T. Hom, S. Sol, T. K. Collier, and U. Varanasi. 1995. Effects of exposure to Prudhoe Bay crude oil on reproductive function in gravid female flatfish. Environmental Sciences 3:67-81.

Johnson, L. L., S.-Y. Sol, D. P. Lomax, G. Nelson, and E. Casillas. 1997. Fecundity and egg weight in English sole (*Pleuronectes vetulus*) from Puget Sound, WA: Influence of nutritional status and chemical contaminants. Fish. Bull. 92:232-250.

Johnson, L. L., B. Norberg, M. L. Willis, H. Zebrowski, and P. Swanson. 1997. Isolation, characterization, and measurement of plasma levels of somatolactin in Atlantic halibut *(Hippoglossus hippoglossus)*. Gen Comp. Endocrinol. 105:194-209.

Landahl, J. T., **L. L. Johnson,** T. K. Collier, J. E. Stein, and U. Varanasi 1997. Marine pollution and fish population parameters: English sole *(Pleuronectes vetulus)* in Puget Sound, WA. Trans. Am. Fish. Soc. 126:519-535.

Johnson, L. L., D. Misitano, S. Sol, G. Nelson, B. French, G. Ylitalo, T. Hom. 1998. Contaminant effects on ovarian development and spawning success in rock sole *(Lepidopsetta bilineata)* from Puget Sound, WA. Trans. Am. Fish. Soc. 127:375-392.

Roubal, W., D. Lomax, M. Willis, and **L. Johnson**. 1997. Purification and partial characterization of English sole vitellogenin. Comp. Biochem. Physiol. 118B:613-622.

Sol, S., O. P. Olson, D. Lomax, and **L. Johnson**. 1998. Gondal development and associated changes in plasma reproductive steroids in English sole *(Pleuronectes vetulus)* from Puget Sound, Washington. Fishery Bulletin. 96:859-870.

Lomax, D.P., W.T. Roubal, J.D. Moore, and **L.L. Johnson.** 1998. Development and validation of an enzyme-linked immunosorbent assay (ELISA) for English sole vitellogenin. Comp. Biochem. Physiol. 121B:425-436.

Johnson, L. L., J. T. Landahl, L. A. Kubin, B. H. Horness, M. S. Myers, T. K. Collier, and J. E. Stein. 1998. Assessing the effects of anthropogenic stressors on Puget Sound flatfish populations. Neth. J. Sea Res.39:125-137.

Ankley, G., A. Fairbrother, S. Bradbury, L.E. Gray, B. Francis, D. Hinton, R. Peterson, **L. Johnson**, G. Vander Kraak, L. Birnbaum. 1999. "Mechanisms of Action of Reproductive Toxicants." *In* Reproductive and Developmental Effects of Contaminants on Oviparous Vertabrates. SETAC Press (in press).

Johnson, L.L., S.Y. Sol, G.M.Ylitalo, T. Hom, B. French, O.P. Olson, and T.K. Collier. 1999. Reproductive Injury in English Sole *(Pleuronectes vetulus)* from the Hylebos Waterway, Commencement Bay, Washington. J. Ecosystem Stress and Recovery (submitted).

Sol, S., **L. Johnson**, B. H. Horness, and T. Collier. 1999. Relationship between oil exposure and reproductive function in fish from Prince William Sound (in review).

Curriculum Vitae — Sean Yongsu Sol

Education

University of Washington, Seattle, WA B.S. 1989 Oceanography

Research and Professional Experience

1990-present Oceanographer, ECD, NMFS, Department of Commerce

1989-1990 Biological Technician, ECD, NMFS, Department of Commerce

1988-1989 Biological Science Aid, U of W/ECD, NMFS, Department of Commerce

Awards

1990, 91, 92, 94, 96 NOAA/NWFSC
Outstanding performance award.

1990 NOAA/NWFSC
Unit Citation for outstanding individual and collective contribution in the Alaska Oil Spill Damage Assessment Program.

1993 NOAA/NWFSC
Spot award.

Scientific Publications

in prep. or in internal review

Sol, S.Y., B. Horness, T. K. Collier, and L. L. Johnson. *(in review).* Relationship between oil exposure and reproductive endpoints in fish collected following the *Exxon Valdez* oil Spill. Submitted to Canadian Journal of Fisheries and Aquatic Sciences.

published or in press

Sol, S.Y., O.P. Olson, D.P. Lomax, and L. Johnson. (1998). Gonadal development and associated changes in plasma reproductive steroids in English sole *(Pleuronectes vetulus)* from Puget Sound, Washington. Fish. Bull. 96:859-870.

Johnson, L. L., D. Misitano, **S. Sol**, G. Nelson, B. French, G. Ylitalo, T. Hom. (1998). Contaminant effects on ovarian development and spawning success in rock sole *(Lepidopsetta bilineata)* from Puget Sound, WA. Trans. Am. Fish. Soc. 127:375-392.

Johnson, L. L., **S.Y. Sol,** D. P. Lomax, G. Nelson, and E. Casillas. (1997). Fecundity and egg weight in English sole *(Pleuronectes vetulus)* from Puget Sound, WA: Influence of nutritional status and chemical contaminants. Fish. Bull. 95:231-249.

Johnson, L. L., **S.Y. Sol,** D. P. Lomax, and T. K. Collier. (1996). Effects Of Endocrine-Disrupting Chemicals On Marine Flatfish Reproduction: An Approach To Environmental Risk Assessment. *In:* Proc. Int. Symp. on Fish Reprod. F. Goetz and P. Thomas, Eds., FishSymp 95, Univ. of Texas at Austin, Marine Sciences Institute, Port Arkansas, Tx. p.188.

Wolfe, D.A., M.M. Krahn, E. Casillas, **S. Sol**, T.A. Thompson, J. Lunz, and J. Scott. (1996). Toxicity of intertidal and subtidal sediments contaminated by the Exxon Valdez oil spill. American Fisheries Society Symposium 18:121-139.

Sol, S.Y., L. L. Johnson, T. K. Collier, M. M. Krahn, and U. Varanasi. (1995). Contaminant effects on reproduction in North Pacific flatfish. *In:* Proceedings of the International

Symposium on North Pacific Flatfish. Alaska Sea Grant College Program Report No. 95-04, University of Alaska Fairbanks. pp. 547-560.

Johnson, L. L., J. E. Stein, T. Hom, **S. Sol**, T. K. Collier, and U. Varanasi. (1995). Effects of exposure to Prudhoe Bay crude oil on reproductive function in gravid female flatfish. Environmental Sciences 3:67-81.

Johnson, L., E. Casillas, **S. Sòl,** T. Collier, J. Stein, and U. Varanasi. (1993). Contaminant effects on reproductive success in selected benthic fish species . Marine Env. Res. 35:165-170.

Casillas, E., D. Weber, C. Haley, and **S. Sol.** (1992). Comparison of growth and mortality in juvenile sand dollars as indicators of contaminated marine sediment. Environmental Toxicology and Chemistry 11:559-569.

2000 EXXON VALDEZ TRUST COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$37.7
Travel		$13.2
Contractual		$20.0
Commodities		$4.0
Equipment		$0.0
Subtotal	$0.0	$74.9
General Administration		$7.1
Project Total	$0.0	$82.0
Full-time Equivalents (FTE)		
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		$2.0			

Dollar amounts are shown in thousands of dollars.

Comments: The estimated budget for FY2000 and FY 2001 is based on partial contribution by NOAA for costs associated with labor, report and manuscript preparation.

FY00

Prepared: 04/09/99

Project Number: New project 00576
Project Title: Relationship between oil exposure and reproductive endpoints in dolly varden
Agency: NOAA

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
T. Collier - NOAA/ECD	Supervisory Research Chemist	GS14/5	0.3	10.7	0.0	3.2
L. Johnson - NOAA/ECD	Research Zoologist	GS13/4	1.0	8.8		8.8
S. Sol - NOAA/ECD	Oceanographer	GS11/4	2.0	6.7		13.4
D. Lomax - NOAA/ECD	Biologist	GS11/4	1.0	6.7		6.7
S. Spencer - NOAA/ECD	Research Chemist	GS11/1	1.0	5.6		5.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		5.3	38.5	0.0	
					Personnel Total	$37.7

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
T. Collier, EVOS Trustee Council workshop, Anchorage, AK	0.8	1	4	0.1	1.2
L. Johnson, travel to Seward AK	1.0	1	30	0.1	4.0
S. Sol, travel to Seward AK	1.0	1	30	0.1	4.0
D. Lomax, travel to Seward AK	1.0	1	30	0.1	4.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$13.2

FY00

Prepared: 04/09/99

Project Number: New project
Project Title: Relationship between oil exposure and reproductive endpoints in dolly varden
Agency: NOAA

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:		Proposed
Description		FY 2000
Charterboat for fishing (1.0K/day for 20 days)		20.0
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$20.0

Commodities Costs:	Proposed
Description	FY 2000
Chemical reagents - NOAA/ECD	2.0
Glassware/laboratory supplies - NOAA/ECD	1.0
Laboratory/office supplies - NOAA/NMML	1.0
Commodities Total	$4.0

FY00

Prepared: 04/09/99

Project Number: New project
Project Title: Contaminant levels in North Pacific killer whales
Agency: NOAA

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
Scintillation counter - NOAA/ECD	1	NOAA/ECD
High pressure liquid chromotography - NOAA/ECD	1	NOAA/ECD

FY00

Project Number: New project
Project Title: Relationship between oil exposure and reproductive endpoints in dolly varden
Agency: NOAA

FORM 3B
Equipment
DETAIL

Prepared: 04/09/99

Manuscript synthesis: Cytochrome P4501A induction, hydrocarbon bioaccumulation and composition, and growth of Pink Salmon (*Oncorhynchus gorbuscha*) fry in Prince William Sound and in laboratory tests.

Project Number:	00590
Restoration Category:	Publication
Proposer:	Mark G. Carls 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:	One year
Cost, FY00:	$10,000
Geographic Area:	Prince William Sound (field work completed)
Injured Resource/Service:	Pink Salmon

ABSTRACT

We propose to complete a manuscript with that combines previously unpublished data with a synthesis of earlier papers concerning juvenile pink salmon and the *Exxon Valdez* oil spill. After the spill in 1989, there was direct and indirect evidence that juvenile pink salmon from oiled areas of Prince William Sound (PWS) were contaminated by oil and had lower growth rates relative to fish from non-oiled areas. Evidence for exposure and contamination included induction of cytochrome P4501A enzymes and elevated concentrations of polynuclear aromatic hydrocarbons (PAH) in fish tissue. Direct ingestion of oil was indicated as an important avenue of fry contamination, and was corroborated by laboratory research. Evidence of growth inhibition in PWS fry is disputed by industry, who suggest exposure concentrations were well below levels known to cause acute or chronic growth effects. In this paper we extend the results with previously unreported P4501A induction and PAH accumulation in laboratory fish, and compare these parameters plus growth to the same measures in fry from PWS in 1989. All three independent assessments of response to oil strongly support previous conclusions that juvenile pink salmon were exposed to significant concentrations of *Exxon Valdez* oil after the spill, and that exposures were biologically significant.

INTRODUCTION

We propose to complete a manuscript with that combines previously unpublished data with a synthesis of two earlier papers concerning juvenile pink salmon and the *Exxon Valdez* oil spill (Carls et al. 1996a; 1996b).

Evidence that the *Exxon Valdez* oil spill in Prince William Sound (PWS), Alaska, negatively affected pink salmon, *Onchorynchus gorbuscha*, remains controversial. Natural Resource Damage Assessment (NRDA) researchers concluded that the growth of juvenile pink salmon was reduced by oil exposure, resulting in poorer survival (Wertheimer and Celewycz 1996; Willette 1996; Geiger et al. 1996). Evidence of growth reduction is disputed by industry, who suggest factors unrelated to oil explained observed differences (Brannon and Maki 1996).

In the proposed paper, we will support evidence that juvenile pink salmon were exposed to concentrations of *Exxon Valdez* oil sufficient to cause reduced growth, and the hypothesis that ingestion of oil was an important route of contamination. Evidence for exposure and contamination of PWS juveniles included induction of cytochrome P4501A enzymes and elevated concentrations of PAH in fish tissue (Carls et al. 1996a). Direct ingestion of oil was indicated as an important avenue of fry contamination (Carls et al. 1996a), and was corroborated by laboratory research (Carls et al. 1996b). Here we extend the results of the field and laboratory research by comparing P4501A induction, PAH accumulation, and growth rates of fry captured in PWS in 1989 to induction, bioaccumulation, and growth in fry exposed via ingestion in the laboratory. Induction of P4501A and PAH accumulation in laboratory fish have not been previously reported.

The relationship between cytochrome P4501A induction and growth in juvenile pink salmon should also corroborate a similar relationship in pink salmon embryos, thus unifying interpretation of early-life history responses. Rice et al. are currently proposing an experiment to relate induction and growth in embryos.

NEED FOR THE PROJECT

A. Statement of Problem

This project will allow completion of a peer-reviewed manuscript designed to further the understanding of the consequences of juvenile pink salmon exposure to oil in PWS following the *Exxon Valdez* oil spill and to counter industry arguments that the spill did not, and could not possibly, have had a negative impact on salmon. The proposed paper will include important new data that was unavailable at the time the first papers were written and synthesize two earlier papers. We also anticipate that this paper will provide important corroborative evidence in support of a proposed cytochrome P4501A induction experiment in embryonic pink salmon.

B. Rationale/Link to Restoration

The proposed manuscript will add to the growing body of peer-reviewed literature supported by Trustee research, will support previous NRDA literature, and will refute no-effect

claims by industry.

C. Location

Prince William Sound is the geographic focus, but this manuscript project does not require additional field or laboratory work.

COMMUNITY INVOLVEMENT

Because all field work has been completed, opportunity for community involvement is very limited.

PROJECT DESIGN

A. Objectives

Goal: Write a manuscript that includes important new data that was unavailable at the time the first papers were written, and synthesizes two earlier papers (Carls et al. 1996a; 1996b).

Specific objectives are to compare and interpret the following parameters in juvenile pink salmon after the *Exxon Valdez* oil spill and in laboratory fish:

1. Total PAH accumulation in tissue (new);
2. Cytochrome P4501A induction (new);
3. Growth (synthesis);
4. PAH composition in tissue.

The first three objectives will provide an independent assessment of the significance of juvenile pink salmon exposure to oil in 1989. Combined, these three independent assessments will strongly support NRDA conclusions that juvenile pink salmon were exposed to significant concentrations of *Exxon Valdez* oil after the spill, and that exposure was biologically significant. Comparison of tissues with P4501A induction and PAH composition in tissues will support the hypothesis that ingestion was a major route of exposure to oil after the spill.

B. Methods.

Final data analysis and writing may require more than one man-month of effort, but only 1 month salary is requested. Writing will be completed between October 1, 1999 and October 1, 2000. Other applicable research, including industry studies, will be discussed. Author interactions will take place at the Auke Bay Laboratory or via email for a remotely located author.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Coauthors will include Alex Wertheimer and Dr. Roxanna Smolowitz. Dr. Stan Rice (Auke Bay Laborabory) will have management oversight, and will serve as a major reviewer and quality control.

SCHEDULE

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

October 1999	Begin final analysis and start first draft
February 2000	Complete first draft, start author review
June 2000	Review of manuscript by non-authors
August 2000	Submit manuscript to journal (target journal has not been determined)

B. Project Milestones and Endpoints

August 2000	Submit manuscript to journal (target journal has not been determined)
September 2000	Complete final report

C. Completion Date

This project would be completed in Fiscal Year 2000.

PUBLICATIONS AND REPORTS

Carls et al. 2000. Cytochrome P4501A induction, hydrocarbon bioaccumulation and composition, and growth of pink salmon (*Oncorhynchus gorbuscha*) fry in Prince William Sound and in laboratory tests. Journal unknown.

PROFESSIONAL CONFERENCES

None

NORMAL AGENCY MANAGEMENT

NOAA/NMFS has statutory stewardship for all living marine resources; however, if the oil spill had not occurred NOAA would not be conducting this project. NOAA/NMFS proposes to contribute any writing time that extends beyond the 1 month salary request.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will be coordinated with other projects conducted by ABL, particularly those involving P4501A induction.

PROPOSED PRINCIPAL INVESTIGATOR, IF KNOWN

Mark G. Carls
NOAA/NMFS
Auke Bay Laboratory
11305 Glacier Hwy
Juneau, AK 99801
Phone: (907) 789-6019; Fax: (907) 789-6094
email: mark.carls@noaa.gov

PRINCIPAL INVESTIGATOR

Mark G. Carls (GS-12 Fishery Biologist)

Received BA (1975) in Biology from Gustavus Adolphus College, St. Peter, MN, and MS (1978) in Biological Oceanography from Dalhousie University, Halifax, Nova Scotia. Mark has been employed at the Auke Bay Fisheries Laboratory since 1979. His principal involvement has been in research of petroleum hydrocarbon toxicology to marine fish and invertebrates, including egg, larval, and adult life stages. Mark has published 17 papers, and has 5 *Exxon Valdez* damage assessment papers in preparation or pending publication. Since 1989, he has been involved as a principal investigator and co-investigator on several studies resulting from the *Exxon Valdez* oil spill involving Pacific herring, pink, and chum salmon, and mussels.

OTHER KEY PERSONNEL

Cooperating authors will include Alex Wertheimer (Auke Bay Laboratory) and Dr. Roxanna Smolowitz (Marine Biological Laboratory, Woods Hole). Dr. Stan Rice, Jeff Short, Ron Heintz, and other colleagues at ABL will assist in reviews and quality control of the manuscript.

LITERATURE CITED

Brannon, E.L, and A.W. Maki. 1996. The Exxon Valdez oil spil: analysis of impacts on the Prince William Sound pink salmon. Rev. Fish. Sci. 4:289-337.

Carls, M. G., A. C. Wertheimer, J. W. Short, R. M. Smolowitz, and J. J. Stegeman. 1996a. Contamination of juvenile pink and chum salmon by hydrocarbons in Prince William Sound after the *Exxon Valdez* oil spill. Am. Fish Soc. Symp. 18:593-607.

Carls, M. G.,L. Holland, M. Larsen, J. L. Lum, D. G. Mortensen, S. Y. Wang, and A. C. Wertheimer. 1996b. Growth, feeding, and survival of pink salmon fry exposed to food contaminated with crude oil. Am. Fish. Soc. Symp. 18:608-618.

Geiger, H.J., B.G. Bue, S. Sharr, A.C. Wertheimer, and T.M. Willette. 1996. A life history approach to estimating damage to Prince William Sound pink salmon caused by the *Exxon Valdez* oil spill. Am. Fish. Soc. Symp. 18:487-498.

Wertheimer, A.C., and A.G. Celewycz. 1996. Abundance and growth of juvenile pink salmon in oiled and non-oiled locations of western Prince William Sound after the *Exxon Valdez* oil spill. Am. Fish. Soc. Symp. 18:509-517.

Willette, M. Impacts of the Exxon Valdez oil spill on the migration, growth, and survival of juvenile pink salmon in Prince William Sound. Am. Fish. Soc. Symp. 18:533-550.

2000 EXXON VALDEZ TRI COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$7.8
Travel		$0.0
Contractual		$0.0
Commodities		$1.0
Equipment		$0.0
Subtotal	$0.0	$8.8
General Administration		$1.2
Project Total	$0.0	$10.0
Full-time Equivalents (FTE)		0.1
Other Resources		$6.9

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

Dollar amounts are shown in thousands of dollars.

NOAA Contribution:
Mark Carls P-I .5 mo @ 3.9K, Dr. Stan Rice, Program Manager, .25 mo @ 3K for a total NOAA contribution of:
6.9K

FY00

Prepared:4/12/99

Project Number: 00___
Project Title: P4501A Induction, Hydrocarbon Bioaccumulation and Reduced Pink Salmon Growth
Agency: NationalOceanic & Atmospheric Administration

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRU ;OUNCIL 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
Matk kCarls - P-I	Fishery Biologist	12/6	1.0	7.8		7.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.0	7.8	0.0	
					Personnel Total	$7.8

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:4/12/99

Project Number: 00___
Project Title: P4501A Induction, Hydrocarbon Bioaccumulation and Reduced Pink Salmon Growth
Agency: NationalOceanic & Atmospheric Administration

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRU :OUNCIL 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	
Publications Page Charges @ 1K	1.0
Commodities Total	$1.0

FY00

Prepared:4/12/99

Project Number: 00___
Project Title: P4501A Induction, Hydrocarbon Bioaccumulation and Reduced Pink Salmon Growth
Agency: NationalOceanic & Atmospheric Administration

FORM 3B
Contractual & Commodities
DETAIL

2000 EXXON VALDEZ TRU :OUNCIL PROJECT BUDGET

October 1, 199- - 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		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY00

Project Number: 00 590
Project Title: P4501A Induction, Hydrocarbon Bioaccumulation and Reduced Pink Salmon Growth
Agency: NationalOceanic & Atmospheric Administration

FORM 3B Equipment DETAIL

Prepared:4/12/99

POPULATION STRUCTURE, GROWTH, MORTALITY AND PRODUCTION OF THE MUSSEL, *MYTILUS TROSSULUS*, IN PRINCE WILLIAM SOUND: PUBLICATION OF STUDY RESULTS

Project Number:	00591
Restoration Category:	General Restoration
Proposer:	Charles E. O'Clair, Mandy Lindeberg NMFS, Auke Bay Laboratory ABL Project Manager: Dr. Stan Rice NOAA Program Manager: Bruce Wright
Lead Trustee Agency:	NOAA
Cooperating Agencies:	None
Alaska Sea Life Center:	no
Duration:	1 year project
Cost FY 00:	$22,700
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pacific Blue Mussel (*Mytilus trossulus*)

ABSTRACT

The project proposed here will be limited to the publication of three papers on population structure, growth, mortality and production in the mussel, *Mytilus trossulus*, in western Prince William Sound. These papers will summarize some of the results of a four year study of *Mytilus* under the Nearshore Vertebrate Predator Study (NVP, Project No. 99025) in which data collection, processing and the bulk of data analysis was completed. However, these papers are not covered in the current NVP closeout detailed plan. Three additional papers have been proposed as appendices to the NVP final report and are included in the NVP closeout detailed plan.

A. INTRODUCTION

The Pacific blue mussel, *Mytilus trossulus*, is a foundation species (*sensu* Dayton 1972) in the intertidal community of Prince William Sound and plays an important role in the nearshore food web as prey for a variety of vertebrate and invertebrate predators. It is ubiquitous on rocky and mixed-sediment substrates in the Sound and forms dense beds in some situations (Babcock et al. 1998) where it provides much of the structure in the mid-intertidal zone. Mussels appear in the diet of several predators in Prince William Sound including: sea otters (*Enhydra lutris*), harlequin ducks (*Histrionicus histrionicus*), Barrow=s goldeneyes (*Bucephala islandica*), black oystercatchers (*Haematopus bachmani*), glaucous-winged gulls (*Larus glaucescens*), mew gulls (*Larus canus*), surfbirds (*Aphriza virgata*), dogwinkles (*Nucella* spp.), and seastars (*Evasterias troschelii*, *Pycnopodia helianthiodes* and *Pisaster ochraceus*; Holland-Bartels 1998, Bishop et al. 1998). Mussels are the preferred prey of Barrow=s goldeneyes.

An aspect of the dynamics of mussel populations important to higher trophic levels in Prince William Sound is the rate at which energy is made available to the higher levels, often estimated as production. There have been relatively few studies of production in natural mussel populations (Seed and Suchanek 1992). No estimates of mussel production in Prince William Sound appear in the published literature or in written reports from the area. Short-term (four months) or annual growth has been measured at several locations in Prince William Sound by various authors (Feder and Keiser 1980, Highsmith et al. 1996, Houghton et al. 1993a), but no author has modeled age-specific growth for any location in the Sound. The three publications here will provide the first estimates of mussel production for Prince William Sound (one paper) that are supported by two additional papers on the spatial and temporal variability in mussel growth and mortality.

NEED FOR PROJECT

A. Statement of Problem

Mussels are currently considered to be recovering from the *Exxon Valdez* oil spill (EVOS). Mussels suffered reduced abundance and growth at oiled shores after the spill. Houghton et al. (1993a, 1993b, 1993c and 1993d) estimated the abundance of *Mytilus* along with other epifauna at 21 locations in western PWS in 1991-92 and found changes resulting from shoreline cleaning. Highsmith et al. (1994) estimated the abundance and biomass of *Mytilus* in late summer/early fall 1989 and in spring/summer 1990 and spring 1991. They found reduced mussel density on oiled shores. Highsmith et al. (1996) found reduced growth at oiled sites in Herring Bay that persisted at least until 1995. Studies of mussel beds in heavily oiled areas revealed high concentrations of relatively unweathered oil in underlying byssal mats and sediments in 1991. As late as 1995 about 30 mussel beds in Prince William Sound still contained *Exxon Valdez* oil residue (Babcock et al. 1998).

B. Rational/Link to Restoration

An understanding of the extent of recovery of intertidal communities and the nearshore ecosystem after the Exxon Valdez oil spill depends on an understanding of the dynamics of populations of mussels as a foundation species in the intertidal community and the potential for exploitation of mussel populations as a food resource for higher trophic levels. The publication of the papers proposed here will provide the first estimates of size-specific growth and production for mussels in Prince William Sound and will provide information on mussel population structure in oiled and unoiled areas where mussels are subject to different levels of vertebrate predation.

C. Location

The proposed project will focus on mussel populations in western Prince William Sound. The data upon which the proposed publications will be based were collected on northwestern Montague Island (an unoiled area with abundant vertebrate predators of mussels) and in Bay of Isles and Herring Bay (oiled bays with fewer vertebrate predators of mussels).

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

These publications will disseminate the results of the mussel studies to the scientific community. No special provisions are made in this proposal to communicate the research findings to affected communities. No community involvement will take place in the publication of these papers.

PROJECT DESIGN

To support the preparation of the three papers proposed here, the project design will involve some data analysis in addition to what has already been completed. The additional analysis will include estimates of age-specific growth, mortality estimates and estimates of somatic production in mussel populations at two study areas in western Prince William Sound. However, most of the effort of the proposed project will be directed toward writing up the results of our completed work.

A. Objective

1. Complete publication of three papers on mussel population structure, growth, mortality and production in western Prince William Sound.

B. Methods

Data collection is complete. No data collection methods will be employed.

Additional data analysis methods will involve estimates of age-specific growth using a

modification of the Schnute general growth model (Baker et al. 1991)

Install Equation Editor and double-click here to view equation.

where Y_m and Y_r are sizes at t_m, age at marking, and t_r, age at recapture, respectively. The parameters, y_1 and y_2 are lengths at ages t_1 and t_2 chosen from among the youngest and oldest ages of observed animals. Parameters a and b define the shape of the curve and are unequal to zero under case 1.

Mark-recapture estimates of mortality will be corrected for tag loss estimated from our double-tagging experiments (Seber 1982). Estimates of somatic production for stocks with recruitment and age classes separable will be calculated according to the method of Crisp (1984).

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Data collection for the proposed study was supported under the Nearshore Vertebrate Predator (NVP) Study. Although preparation of the proposed publications will not involve other Principal Investigators of that study, the Chief Scientist of the NVP Study will be kept informed of the status of the publications proposed here.

SCHEDULE

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

October 1 - November 30	Complete final data analysis and write manuscript on the relationship between mortality and growth of *Mytilus trossulus* and environmental variables such as tidal height, slope and substrate class in Prince William Sound, Alaska
December 1 - April 15	Complete final data analysis and write manuscript on standing stock and production of *Mytilus trossulus* in two areas of Prince William Sound with different histories of oiling.
April 15 - September 30	Complete final data analysis and write manuscript on regional differences in the growth of *Mytilus trossulus* in the Gulf of Alaska.

B. Project Milestones and Endpoints

November 30, 1999	Submit manuscript on mortality and growth of *Mytilus trossulus* with tidal height, slope and substrate class in Prince William Sound, Alaska to the journal.

April 15, 2000 Submit manuscript on standing stock and production of *Mytilus trossulus* in two areas with different histories of oiling in Prince William Sound, Alaska to the journal.

September 30, 2000 Submit manuscript on regional differences in the growth of *Mytilus trossulus* in the Gulf of Alaska to the journal.

C. Completion Date

September 30, 2000

PUBLICATIONS AND REPORTS

All manuscripts will be completed and submitted in FY00. Titles are listed below:

1. Mortality and growth of *Mytilus trossulus* with tidal height, slope and substrate class in Prince William Sound, Alaska.. O=Clair, Millstein and Lindeberg. Marine Biology

2. Standing stock and production of *Mytilus trossulus* in two areas with different histories of oiling in Prince William Sound, Alaska. O=Clair, Lindeberg and Millstein. Marine Ecology - Progress Series

3. Regional differences in the growth of *Mytilus trossulus* in the Gulf of Alaska. Lindeberg, O=Clair and Saupe. Veliger.

PROFESSIONAL CONFERENCES

No travel funds are requested for attendance at conferences. The principal investigators will be attending the annual *Exxon Valdez* workshop under separate funding.

NORMAL AGENCY MANAGEMENT

Natural mussel populations are not managed in Alaska. The National Marine Fisheries Service does not normally conduct research on mussels.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The publication of the papers proposed here will be coordinated with the publication activity of the Nearshore Vertebrate Predator Study through direct communication with the Chief Scientist and Principal Investigators of that project.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This is not a continuing project.

PROPOSED PRINCIPAL INVESTIGATORS

Charles E O=Clair
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11305 Glacier Highway
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Tele: (907) 789-6016, FAX: (907) 789-6094
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Tele: (907) 789-6616
email: mandy.lindeberg@noaa.gov

PRINCIPAL INVESTIGATORS

Charles E. O=Clair and Mandy Lindeberg will share in the responsibility of data analysis and interpretation and manuscript preparation. 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'Clair, 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

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Babcock, M. M., P. M. Harris, M. G. Carls, C. C. Brodersen, and S. D. Rice. 1998. Mussel Bed Restoration and Monitoring. *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 95090), National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Auke Bay Laboratory, Juneau, Alaska.

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Dayton, P.K. 1972. Toward an understanding of community resilience and the potential effects of enrichments to the benthos at McMurdo Sound, Antarctica. pp. 81-96. *In* B.C. Parker (Ed.) Proceedings of the colloquium on conservation problems in Antarctica. Allen Press, Lawrence, Kansas.

Feder, H.M. and G.E. Keiser. 1980. Intertidal Biology. pp. 145-233. *In* J.M. Colonell, ed., Port Valdez, Alaska: Environmental Studies 1976-1979. Inst. Mar. Sci. Occas. Publ. No. 5, Univ. Alaska, Fairbanks.

Highsmith, R. C., M. S. Stekoll, P. G. van Tamelen, S. M. Saupe, T. L. Rucker, and L. Deysher 1996. Herring Bay Experimental and Monitoring Studies. *Exxon Valdez* oil spill Restoration Project Final Report (Restoration Project 94086), Vols. I and II. Institute of Marine Science School of Fisheries and Ocean Sciences, Univ. of Alaska Fairbanks, Fairbanks, Alaska.

Holland-Bartels, L., and various authors. 1998. Mechanisms of impact and potential recovery of nearshore vertebrate predators. Exxon Valdez Oil Spill Restoration Project Annual Report (Restoration Project 97025). National Biological Service, Anchorage, Alaska.

Houghton, J. P., A. K. Fukuyama, D. C. Lees, H. Teas, III, H. L. Cumberland, P. M. Harper, T.

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2000 EXXON VALDEZ TRI COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000						
Personnel		$17.6						
Travel		$0.0						
Contractual		$0.0						
Commodities		$2.5						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$20.1			Estimated FY 2001	Estimated FY 2002		
General Administration		$2.6						
Project Total	$0.0	$22.7			$0.0			
Full-time Equivalents (FTE)		0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

NOAA Contribution:
CE O'Clair P-I 1 mo @ 8.6K for a total NOAA contribution of 8.6K.

FY00

Prepared:4/12/99

Project Number: 00591
Project Title: Publication of *Mytilus* Population Manuscripts
Agency: National Oceanic and Atmospheric Administration

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRI 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	1.5	8.6		12.9
Lindeberg, M.	Fishery Research Biologist	GS-9	1.0	4.7		4.7
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.5	13.3	0.0	
					Personnel Total	$17.6

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:4/12/99

Project Number: 00___
Project Title: Publication of Mytilus Population Manuscripts
Agency: National Oceanic and Atmospheric Administration

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TR 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
Printing and Publication Costs	2.5
Commodities Total	$2.5

FY00

Prepared:4/12/99

Project Number: 00___
Project Title: Publication of Mytilus Population Manuscripts
Agency: National Oceanic and Atmospheric Administration

FORM 3B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TR 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	Inventory Agency

FY00

Prepared:4/12/99

Project Number: 00___
Project Title: Publication of Mytilus Population Manuscripts
Agency: National Oceanic and Atmospheric Administration

FORM 3B
Equipment
DETAIL

A TAXONOMIC SYNTHESIS OF INTERTIDAL ALGAE FOR PRINCE WILLIAM SOUND

Project Number:	00592
Restoration Category:	Synthesis, Integration, and Publication
Proposer:	Mandy Lindeberg NMFS, Auke Bay Laboratory ABL Program Manager: Dr. Stan Rice NOAA Program Manager: Bruce Wright
Lead Trustee Agency:	NOAA
Cooperating Agencies:	NOAA Hazardous Materials Response and Assessment Div. Kachemak Bay National Estuarine Research Reserve
Alaska Sea Life Center:	no
Duration:	2 years
Cost FY 00:	$35,400
Cost FY 01:	$35,000
Geographic Area:	Prince William Sound
Injured Resource/Service:	Intertidal Algae

ABSTRACT

Intertidal communities are among the resources that have not fully recovered from the EVOS. Intertidal algae or Aseaweed@ is an important component of the coastal habitat and a resource for subsistence and commercial harvests. The spill offered a unique opportunity for researchers of several projects to collect algal specimens over a large and remote coastal area previously unexplored by scientists. This project will synthesize the taxonomic and technical information gained by these researchers into an intertidal algae of Prince William Sound field guide. An interactive CD-ROM with world wide web capabilities would also supplement the field guide. This project will also produce a Restoration Notebook Series publication on PWS marine algae. Future researchers and the public will be able to use these publications as a reference previously non-existent to this area.

A. INTRODUCTION

Among the resources that have not fully recovered from the EVOS are intertidal communities. This has been established by the Coastal Habitat Project funded by the Trustee Council (Highsmith et al. 1994, 1995, 1996; Stekoll et al. 1996) and the NOAA Haz. Mat. monitoring studies (Houghton et al 1991, 1995, 1996a and 1996b). The spill offered a unique opportunity for researchers to collect specimens of intertidal invertebrate and algal species over a large and remote coastal area previously unexplored by scientists. Under the Coastal Habitat Project over 5,000 algal specimens were placed in a database and archived in a registered herbarium. Many of these dried specimens are direct evidence of range extensions to the northern latitudes and may hold important morphological and genetic information for other researchers. With multi-agency cooperation this two year project will synthesize the taxonomic and technical data acquired by these studies into a field guide and interactive CD-ROM. This information can also be expanded to the world wide web and become part of the Restoration Notebook Series.

NEED FOR PROJECT

A. Statement of Problem

Basic taxonomic and distribution literature on intertidal algal species in Prince William Sound has been non-existent. The rigorous Coastal Habitat project and the NOAA Hazmat Monitoring study provided a unique opportunity for researchers to conduct a thorough survey of intertidal algal species in this region. Unfortunately, very little information acquired by the Coastal Habitat Project has been available to other researchers or the public. There is a need to synthesize the information gained by these two projects and develop a taxonomic and technical field guide on intertidal algae of Prince William Sound.

B. Rational/Link to Restoration

This project relates to the Trustees objective of integration and synthesis of information from damage assessment and restoration projects. Future researchers will be able to use this publication as a specific, geographical taxonomic reference for monitoring. The product from this work will also serve as educational tools for the public.

C. Location

Prince William Sound.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Although the community will not be directly involved, intertidal algae have been used

traditionally by locals for subsistence and commercial harvests related to the herring roe on kelp fishery. Those species targeted by locals for subsistence and commercial harvests will be a category included in the field guide.

PROJECT DESIGN

A. Objectives

1. To produce a taxonomic and technical field guide of intertidal algae for Prince William Sound based on rigorous research stemming from the EVOS.

2. To produce PWS algae Restoration Notebook Series publication.

3. To produce an interactive CD-ROM to supplement the hard copy of the field guide.

4. To provide the interactive CD-ROM for inclusion on the EVOS Restoration Office web site.

B. Methods

The first phase will be synthesizing a species list from the Coastal Habitat and NOAA Hazmat studies, compiling a literature survey on taxonomy/life history and distribution, developing a field guide outline, and producing photographs of live and dried specimens that will structure the field guide.

The second phase will be writing the field guide based on the compiled information and creating a document in a format which can also be easily converted into an interactive CD-ROM to supplement the book. Please see the attached draft template with hypertext. A Restoration Notebook Series publication can also be produced at this point.

The third phase will involve a review process of the draft field guide and the printing/production of the final version of the field guide/CD-ROM.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Other agencies assisting in the development of this field guide are NOAA Hazmat and the Kachemak Bay National Estuarine Research Reserve (KBNERR) who believe this product would aid in their research objectives and mission statements. Also, we will work closely with UAF scientists when incorporating the Coastal Habitat marine algae data.

Fucus gardneri

Authority/Other Scientific Names:
Silva; *F. distichus*

Visual Identification:
A *discoidal* holdfast supports a *dichotomously* branched thallus with midrib throughout vegetative portions. Reproductive adult thalli have distinctive air filled badders called *receptacles*. Thalli are known to produce quite a lot of mucus.

Habitat:
Fucus dominates the mid intertidal of most Alaskan beaches. It forms a short canopy that protects other species of seaweed and intertidal invertebrates. *Fucus* is a perennial and a resilient species tolerating wide ranges in salinity, temperature, and desiccation. It can be found on the outer coast, in sheltered bays and near the mouths of streams.

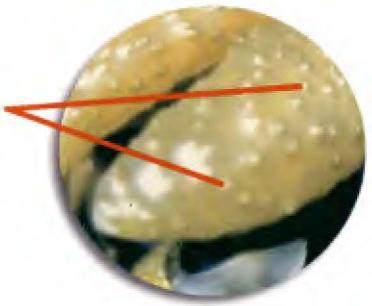
Life History:
Fucus gametes develope in chambers called *conceptacles* found on the *receptacles*. Tidal cycles of hydration and desiccation squeeze out the gametes and the eggs become fertilized. Fertile eggs settle into cracks found in the substrate where they are protected from desiccation and grazers. In 1-2 years *germlings* are visible under the canopy of adult thalli. Individuals become reproductive adults in 3-4 years and may survive to 5 years (VanTamelen, 1994).

Commercial/Subsistence Uses:
In Alaska *Fucus* is harvested to collect herring roe for commercial and subsistence purposes. *Fucus* is edible and young plants' tender tips may be eaten raw or the whole plant can be dried and ground into a powder.

Fucus gardneri
"Rockweed"

P: Phaeophyta
O: Fucales
F: Fucaceae

Key Structures:
Close-up of receptacles showing bumps called conceptacles.



Distribution:

Dried Specimen

Size: 50cm (20")

SCHEDULE

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

Oct 1-Dec 31:	Compile species list and literature search.
January 18-28:	Attend Annual Restoration Workshop.
February 1-March 15:	Develop field guide outline and electronic template.
April 15:	Provide Restoration Notebook Series publication on PWS algae.
April 15-Sep30:	Compile graphic and photographic material and digitize.

B. Project Milestones and Endpoints

Synthesis of the available information and compiling all appropriate materials will be completed during FY00. The first half of FY01 will be writing a draft field guide for review and the second half producing a final version with CD ready format. Copies of the CD-ROM will be provided to the EVOS Restoration Office.

C. Completion Date

The project would be completed at the end of the Fiscal Year 2001

PUBLICATIONS AND REPORTS

The intertidal algal field guide with CD-ROM would be the final product. Another product will be the Restoration Notebook Series publication, AMarine Algae of PWS@.

PROFESSIONAL CONFERENCES

No funding is being requested for attendance at professional conferences other than the EVOS Trustee Council Symposium in FY00.

NORMAL AGENCY MANAGEMENT

Marine algae are important components of the PWS ecosystem. However, NOAA and the state of Alaska agencies do not have the resources or mandates to do intertidal algae work. This information will be very beneficial to the state of Alaska, federal and university scientists.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

A collaborative effort to work on a pilot prototype field guide by NOAA Hazmat and the Kachemak Bay National Estuarine Research Reserve (KBNERR) has already been established. Funding for additional photographic material of live specimens for publication purposes will go into motion this summer in Kachemak Bay using the Kasitsna Bay Laboratory through NOAA Hazmat and KBNERR. Production graphics, layout, printing, and CD-ROM services will be provided by NOAA Hazmat in Seattle. Also, they can provide support on web design, layout, and implementation. Additional collaboration will be conducted with the Principle Investigators of the Coastal Habitat Project for reviewing species lists and archived specimens.

PROPOSED PRINCIPAL INVESTIGATORS

Mandy Lindeberg
National Marine Fisheries Service
Auke Bay Laboratory
11305 Glacier Highway
Juneau, AK 99801-8626
Tele: (907) 789-6616, FAX: (907) 789-6094
e-mail: mandy.lindeberg@noaa.gov

PRINCIPAL INVESTIGATORS

Since 1990 Mandy Lindeberg has been studying the intertidal algal species of Prince William Sound for the major projects involved with damage assessment, restoration, and monitoring of the coastal habitat after the EVOS. These projects include the Coastal Habitat Injury Assessment project, the Herring Bay Restoration studies, and the NOAA hazmat monitoring project. Mandy=s unique position of having detailed knowledge of these data sets and of algal taxonomy is an advantage for integrating and synthesizing algal information into a field guide. Other involvement with Trustee funded research includes the Nearshore Vertebrate Predator project and a co-Principle Investigator for a newly funded spot shrimp project. See curriculum vitae below.

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. In 1998 I became a co-PI for a Trustee funded spot shrimp project 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 (Co-authors)

Gary Shigenaka
Marine Biologist
Hazardous Materials Response and Assessment Division
Biological Assessment Team (BAT)
7600 Sand Point Way NE
Seattle, WA 98115
(206) 526-6402 shig@hazmat.noaa.gov

Gary Shigenaka plays a key role in collaborating efforts with the NOAA Hazmat project, KBNERR, and as an additional funding source. He is dedicated to the production of a taxonomic and technical field guide on intertidal algae with CD-ROM for Prince William Sound to supplement ongoing monitoring.

Dr. Terry Klinger
Univ. of Washington
Friday Harbor Lab

Dr. Klinger=s services will be provided by NOAA Hazmat and used for taxonomic validation of questionable species during the Kachemak Bay collections and later on for similar validations of Coastal Habitat archived specimens.

Lisa Thomas (lisat@ealge.ptialaska.net) will be the contact for the collaborating agency KBNERR.

LITERATURE CITED

Highsmith, R. C., M. S. Stekoll, P. van Tamlen, A. J. Hooten, S. M. Saupe, L. Deysher, and W. P. Erickson. 1995. Herring Bay monitoring and restoration studies. *Exxon Valdez* Oil Spill Restoration Project Final Report (Proj. No. 93039).

Highsmith, R. C., M. S. Stekoll, W.E. Barber, L. McDonald, D. Strickland, and W. P. Erickson. 1994. Comprehensive assessment of coastal habitat. Coastal habitat study No. 1A. Final Report. Report to the *Exxon Valdez* Oil Spill Trustee Council, Anchorage, AK.

Highsmith, R. C., T. L. Rucker, M. S. Stekoll, S. M. Saupe, M. R. Lindeberg, R. N. Jenne, and W. P. Erickson. 1996. Impact of the *Exxon Valdez* oil spill on intertidal biota. Pages 212-237 *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.

Houghton, J. P., A. K. Fukuyama, D. C. Lees, P. J. Hague, H. L. Cumberland, P. M. Harper, and W. B. Driskell. 1993. Evaluation of the condition of Prince William Sound shorelines following the *Exxon Valdez* oil spill and subsequent shoreline treatment. Volume II. 1991 Biological Monitoring Survey. NOAA Technical Memorandum NOS ORCA 73. NOAA, Seattle, WA.

Houghton, J. P., D. C. Lees, H. Teas, H. Cumberland, S. Landino, and W. B. Driskell. 1991. Evaluation of the condition of intertidal and shallow subtidal biota in Prince William Sound following the *Exxon Valdez* oil spill and subsequent shoreline treatment. Volume I. Prepared by Pentec Environmental Inc., and ERC Environmental and Energy Services Co., for NOAA Hazardous Materials Response Branch, Seattle, WA. Report No. HMRB 91-1.

Houghton, J. P., D. C. Lees, W. B. Driskell, S. C. Lindstrom and A. J. Mearns. 1996b. Recovery of Prince William Sound intertidal epibiota from *Exxon Valdez* oiling and shoreline treatments, 1989 through 1992. Pages 379-411 *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.

Houghton, J. P., R. H. Gilmour, D. C. Lees, P. J. Hague, W. B. Driskell, and S. C. Lindstrom. 1996a. Evaluation of the condition of Prince William Sound shorelines following the *Exxon Valdez* oil spill and subsequent shoreline treatment. Volume I. 1994 Biological Monitoring Survey. NOAA Technical Memorandum NOS ORCA 91. NOAA, Seattle, WA.

Houghton,J. P., R. H. Gilmour, D. C. Lees, P. J. Hague, H.L. Cumbeland, P. M. Harper, W. B. Driskell, and S. C. Lindstrom. 1995. Evaluation of the condition of Prince William Sound shorelines following the *Exxon Valdez* oil spill and subsequent shoreline treatment. Volume I. 1993 Biological Monitoring Survey. NOAA Technical Memorandum NOS ORCA 82. NOAA, Seattle, WA.

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.

2000 EXXON VALDEZ TRI COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$28.2
Travel		$3.0
Contractual		$0.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$31.2
General Administration		$4.2
Project Total	$0.0	$35.4
Full-time Equivalents (FTE)		0.5
Other Resources		$35.0

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 2001	Estimated FY 2002
$35.0	$0.0

Dollar amounts are shown in thousands of dollars.

Comments:

Collaborating Agency Contributions:

NOAA Hazmat: ($35K) CD-ROM design, graphic support, production, supplies, taxonomic support, and web page support.

KBNERR: field facility and equipment.

Mandy Lindeberg 1 mo@ 4.7K, Bonita Nelson Fishery Biologist 1.5mo@9 K , Dr. Stan Rice Habitat Program Manager .5 mo@ 6.6K for a total NOAA contribution of 19K

FY00

Prepared:4/12/99

Project Number: 00 592
Project Title: A Taxonomic Synthesis of Intertidal Algae for PWS
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRI COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FY 2000
Name	Position Description					
M. Lindeberg	Research Fisheries Biologist	9/2	6.0	4.7		28.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		6.0	4.7	0.0	
					Personnel Total	$28.2

Travel Costs:	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 2000
Description					
Juneau/Anchorage - Trustee Workshop	0.4	1	3	0.2	1.0
Juneau/Homer - KBNERR collaborative effort.	0.6	1	2	0.2	1.0
Juneau/Seattle - for collaborative effort on CD-ROM development.	0.4	1	3	0.2	1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.0

FY00

Prepared:4/12/99

Project Number: 00___
Project Title: A Taxonomic Synthesis of Intertidal Algae for PWS
Agency: NOAA

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRI COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed FY 2000
Description	
none	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

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

FY00

Prepared:4/12/99

Project Number: 00___
Project Title: A Taxonomic Synthesis of Intertidal Algae for PWS
Agency: NOAA

FORM 3B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRI COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
none			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Computer/Software		
Compound Microscope		
Photographic Equipment		

FY00

Prepared:4/12/99

Project Number: 00___
Project Title: A Taxonomic Synthesis of Intertidal Algae for PWS
Agency: NOAA

FORM 3B
Equipment
DETAIL

Manuscript: Resolution of Mixtures Containing Exxon Valdez Oil and Regional Background Hydrocarbons in Subtidal Sediments of Prince William Sound.

Project Number:	00598
Restoration Category:	Publication
Proposer:	Jeffrey W. Short NMFS, Auke Bay Laboratory ABL Program Manager: Dr. Stan Rice NOAA Program Manager: Bruce Wright
Lead Trustee Agency:	National Marine Fisheries Service
Cooperating Agencies:	None
Alaska Sea Life Center:	No
Duration:	One year
Cost, FY00:	$13,500
Cost, FY01:	$0
Geographic Area:	Prince William Sound (field work completed)
Injured Resource/Service:	Pink Salmon

ABSTRACT

Using existing hydrocarbon data, this paper will report application of multivariate statistical methods to the problem of resolving a hydrocarbon mixture from two different sources in subtidal sediments of Prince William Sound, *viz.*, *Exxon Valdez* oil (EVO) and the the regional background hydrocarbon pattern. Multivariate logistic and Dirichlet error distributions will be compared as bases for maximum likelihood mixture compositions, under the assumption that one source (EVO) is time-varying in composition, and the other (regional background from coal) is not. The large hydrocarbon database produced for the *Exxon Valdez* oil spill will be used to evaluate the performance of these approaches. Results will be used to evaluate biases inherent in a previous bivariate approach to resolution of these mixtures, which had erroneously assumed that both hydrocarbon sources were time-varying, and had concluded that EVO contributed a small increment on a large background in shallow subtidal sediments. The actual extent of initial and present pollution of these sudtidal sediments bears directly on biotic exposure to bioavailable PAH associated with the epibenthos in this region.

INTRODUCTION

The extent to which shallow, subtidal sediments were polluted by Exxon Valdez oil (EVO) remains unsettled, largely because resolution of the polluting oil from natural background hydrocarbons is so difficult. Previous studies sponsored by the Trustees have demonstrated considerable fluxes of EVO to shallow subtidal sediments, which in some cases appeared to have caused substantial increases in the sediment hydrocarbon burden based on mass-balance arguments. Studies sponsored by Exxon corporation have concluded that these increases were negligible in most cases, based on a bivariate mixing model involving a major assumption that was later invalidated. Exploration of this issue using more sophisticated multivariate methods has not been attempted, although such methods make far more efficient use of the available data than either of the previous approaches, with the attendant promise of far more rigor. Resolution of this issue is important because it addresses a fundamental question regarding the extent of initial and continuing exposure of biota to toxic hydrocarbons: How much EVO polluted the seafloor in the spill area?

The work proposed will examine benthic sediment hydrocarbon data already in hand from the spill region, using multivariate statistical methods that realistically incorporate the time-varying aspects of one of the sources (EVO), the time-invariant aspect of the other (coal), and make efficient use of the large number of independent analytes available.

NEED FOR THE PROJECT

A. Statement of Problem

The Exxon-sponsored conclusion of negligible pollution of subtidal sediments by EVO (Page *et al.*, 1996) rest on two inherent biases. First, these studies assume that the natural background source is another crude oil, and therefore weathers the same way that EVO does. Recent work (Short *et al.*, 1999) invalidates this assumption, and showed that the background almst certainly derives from coal. The hydrocarbon pattern of coal does not weather. The Exxon method for allocating hydrocarbon sources systematically overestimates contributions from a source that weathers less rapidly than assumed. Since coal does not weather at all, contributions from coal become progressively more over-estimated as the oil in a sediment mixture weathers. Second, the Exxon approach is based on only two of dozens of hydrocarbon analytes measures, and underestimates analytical variability. These problems may exacerbate the biases that result from source mis-identification.

More extensive and persistent pollution of shallow subtidal sediments by EVO than has been recognized by *e.g.* Page *et al.* (1996) may corroborate other indications of oil exposure in biota associated with these sediments. The proposed project will allow more precise and definitive estimates of the extent that biota in the shallow subtidal were exposed to oil pollution from the T/V *Exxon Valdez.*

B. Rationale/Link to Restoration

The proposed manuscript will add to the growing body of peer-reviewed literature supported by Trustee research, will support previous EVOS literature, and will refute no-effect claims by industry.

C. Location

Prince William Sound is the geographic focus, but this manuscript project does not require additional field or laboratory work.

COMMUNITY INVOLVEMENT

Because all field work has been completed, opportunity for community involvement is very limited.

PROJECT DESIGN

A. Objectives

Goal: Write a manuscript comparing results of multivariate statistical resolution of EVO and coal in subtidal sediment with bivariate results reported by Page et al. (1996).

B. Methods.

Multivariate resolution of hydrocarbon mixtures from two sources will follow the general methods presented by Bandeen-Roche (1994). This involves derivation of maximum liklihood estimates for source contributions based on assumptions about the underlying multivariate error distributions. Two error distributions will be compared, the logistic and the Dirichlet. Substantial agreement between these two approaches will be taken as validation of the overall approach. Results on source contribution estimates derived from the multivariate approach will be compared with results derived from the Page et al (1996) approach to evaluate systematic bias in the latter as EVO weathering proceeds.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

None

SCHEDULE

A. Measurable Project Tasks for FY98 (October 1, 1999 - September 30, 2000)

October 1999	Begin final analysis and start first draft
February 2000	Complete first draft, start author review
June 2000	Review of manuscript by non-authors
August 2000	Submit manuscript to journal (target journal has not been determined)

B. Project Milestones and Endpoints

October 1999	Begin final analysis and start first draft
February 2000	Complete first draft, start author review
June 2000	Review of manuscript by non-authors
August 2000	Submit manuscript to journal (target journal has not been determined)

C. Completion Date

This project would be completed in Fiscal Year 2001.

PUBLICATIONS AND REPORTS

Peer-reviewed manuscript and final report.

PROFESSIONAL CONFERENCES

One presentation is anticipated

NORMAL AGENCY MANAGEMENT

NOAA/NMFS has statutory stewardship for all living marine resources; however, if the oil spill had not occurred NOAA would not be conducting this project. NOAA/NMFS proposes to contribute any writing time that extends beyond the 1 month salary request.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will complete work funded under Trustee project 290 in previous years to identify and interpret hydrocarbon signals in the oil spill region.

PROPOSED PRINCIPAL INVESTIGATOR, IF KNOWN

Jeffrey W. Short
NOAA/NMFS
Auke Bay Laboratory
11305 Glacier Hwy

Juneau, AK 99801
Phone: (907) 789-6065; Fax: (907) 789-6094
email: jeff.short@noaa.gov

PRINCIPAL INVESTIGATOR

Jeffrey W. Short

Education: M.S. (Physical Chemistry)

Relevant Experience:
1989- Present: Established and managed the hydrocarbon analysis facility at ABL to analyze hydrocarbon samples generated by the *Exxon Valdez* NRDA effort (about 20% of these samples were analyzed at ABL).
1989 - 1992: Principal Investigator, Exxon Valdez project Air/Water #3: Determination of petroleum hydrocarbons in seawater by direct chemical analysis and through the use of caged mussels deployed along the path of the oil spill.
1991 - 1996: Principal Investigator, Exxon Valdez project Subtidal #8: Development of computer-based statistical methods for global examination of sediment and mussel hydrocarbon data produced for the Exxon Valdez NRDA effort for systematic bias, and for identification of probable sources of hydrocarbons.
1996 - present: Principal Investigator, Restoration Project 290, Database Management: Discovered particulate coal on beaches near Katalla is a major source of background PAH in marine sediments of the spill area.

OTHER KEY PERSONNEL

Dr. Jerome Pella, Statistician (ABL)

LITERATURE CITED

Bandeen-Roche, K. 1994. Resolution of Additive Mixtures into Source components and Contributions: A Compositional Approach. J. Am. Stat. Assn. **89**:1450-1458

Page, D. S., P. D. Boehm, G. S. Douglas, A. E. Bence, W. A. Burns, and P. J. Mankiewicz. 1996. The Natural Petroleum Hydrocarbon Background in Subtidal Sediments of Prince William Sound, Alaska, USA. Environ. Toxicol. & Chem. **15**:1266-1281

Short, J. W., K. A. Kvenvolden, P. R. Carlson, F. D. Hostettler, R. J. Rosenbauer, and B. A. Wright. 1999. Natural Hydrocarbon Background in Benthic Sediments of Prince William Sound, Alaska: Oil vs. Coal. Environ. Sci. Technol. **33**:34-42

2000 EXXON VALDEZ TRU :OUNCIL PROJECT BUDGET

October 1, 199- - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$10.2
Travel		$1.2
Contractual		$0.0
Commodities		$0.6
Equipment		$0.0
Subtotal		$12.0
General Administration		$1.5
Project Total		$13.5
Full-time Equivalents (FTE)		0.1
Other Resources		$27.0

LONG RANGE FUNDING REQUIREMENTS

		Estimated FY 2001	Estimated FY 2002		

Dollar amounts are shown in thousands of dollars.

NOAA Contribution:
Habitat Senior Research Chemist, J Short 1.0 mo.@ 9.4 K, Senior Statistician Jerry Pella 1.0 mo @ 11.0 K, Program Manager, Stan Rice .5 mo @ 6.6K for a total NOAA contribution of: 27K

FY00

Prepared:4/12/99

Project Number: 00 598
Project Title: Resolution of Mixtures Containing EV Oil and Regional Background Hydroground and Subtital Sediments of PWS
Agency: National Oceanic and Atmospheric Administration

FORM 3A TRUSTEE AGENCY SUMMARY

2000 EXXON VALDEZ TRU :OUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
Jerry Pella	Senior Statistician	13/7	0.5	11.0		5.5
						0.0
Jeff Short	Senior Research Chemist	13/4	0.5	9.4		4.7
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.0	20.4	0.0	
					Personnel Total	$10.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
Juneau - San Francisco- American Chemical Society Meeting	0.8	1	2	0.2	1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.2

FY00

Prepared:4/12/99

Project Number: 00___
Project Title: Resolution of Mixtures Containing EV Oil and Regional Background Hydroground and Subtital Sediments of PWS
Agency: National Oceanic and Atmospheric Administration

FORM 3B Personnel & Travel DETAIL

2000 EXXON VALDEZ TRU 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
Page Charges	0.6
Commodities Total	$0.6

FY00

Prepared:4/12/99

Project Number: 00___
Project Title: Resolution of Mixtures Containing EV Oil and Regional Background Hydroground and Subtital Sediments of PWS
Agency: National Oceanic and Atmospheric Administration

FORM 3B
Contractual & Commodities
DETAIL

2000 EXXON VALDEZ TRU 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		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY00

Prepared:4/12/99

Project Number: 00___
Project Title: Resolution of Mixtures Containing EV Oil and Regional Background Hydroground and Subtital Sediments of PWS
Agency: National Oceanic and Atmospheric Administration

FORM 3B Equipment DETAIL

Evaluation of Yakataga Oil Seeps as Regional Background Hydrocarbon Sources in Benthic Sediments of the Exxon Valdez Spill Area

Project Number:	00599
Restoration Category:	Research and Monitoring
Proposer:	Jeffrey W. Short NMFS, Auke Bay Laboratory ABL Program Manager: Dr. Stan Rice NOAA Program Manager: Bruce Wright
Lead Trustee Agency:	NOAA
Cooperating Agencies:	U. S. Geological Survey Payne Environmental Consultants
Alaska Sea Life Center:	No
Duration:	1 year
Cost FY00:	$ 94,100
Cost FY01:	$ 10,000 (closeout)
Cost FY02:	Nil
Cost FY03:	Nil
Geographic Area:	Gulf of Alaska
Injured Resource/Service:	Benthic Sediments

ABSTRACT

This project will evaluate fluxes of crude oil from terrestrial oil seeps and of particulate coal near Yakataga into the northern Gulf of Alaska to delineate the extent of "natural oil pollution" in the area affected by the Exxon Valdez oil spill.

INTRODUCTION

Scientists contracted by Exxon corporation have claimed that benthic coastal sediments of the northern Gulf of Alaska (GOA), including Prince William Sound (PWS), receive crude oil produced naturally by terrestrial oil seeps at Katalla and Yakataga. If true, this suggests that the marine biota of the EVOS spill area are adapted to oil pollution, thus promoting recovery of species exposed to toxic components of oil spilled from the T/V *Exxon Valdez*. Thus, fauna that show induction of cytochrome-P450 in the spill area may be responding to natural oil pollution and not to the spilled oil. A recent study by Trustee scientists casts considerable doubt on oil from Katalla as a candidate source of hydrocarbons in these sediments, hence sources near Cape Yakataga have been emphasized by the Exxon team. The study proposed here will compare hydrocarbon transport from oil seeps with coal deposits in drainages where oil seeps or particulate coal particles have been located in the Cape Yakataga area, to resolve the relative contributions from these two alternatives to benthic sediments offshore of these drainages in the GOA. Resolution of coal and sediment-bound oil will be achieved by physical separation, with less dense coal particles floated off from the more-dense inorganic fraction of sediments in an aqueous brine solution of intemediate density.

NEED FOR THE PROJECT

A. Statement of Problem

Long-term toxic effects of the oil spilled by the T/V *Exxon Valdez* may be confounded by the presence of other sources of crude oil affecting the spill area. Oil seeps near Cape Yakataga continue to be promoted as significant alternative sources of crude oil in PWS. Coal from terrestrial source beds has also been verified as a hydrocarbon source. However, toxic hydrocarbons in coal are sequestered and not available biologically, consequently they are incapable of inducing molecular indicators of PAH exposure (i.e. cytochrome P450). If the terrestrial oil seeps near Cape Yakataga are shown to be negligible compared to coal beds there, then cytochrome P450 induction that continues to be observed in some non-recovered species within the spill area are more likely the result of exposure to residual oil spilled from the T/V *Exxon Valdez*.

B. Rationale

The criteria used to evaluate recovery of sediments and of biota that continue to show increased cytochrome P450 depends on the extent of background oil contamination in the affected area from sources other than the T/V *Exxon Valdez*. This project will provide much more precise criteria for these assessments. Oil from terrestrial seeps at Katalla and near Cape Yakataga was claimed to have associated with fine-grained sediments, flushed into the norther GOA, and then transported by the ACC into PWS where the sediments deposited in the calmer waters there. However, these studies ignored the possibility that terrestrial coal deposits could be a more dominant source in these areas. Although such coal deposits have been verified as dominant

sources at Katalla, coal sources have not as yet been documented in the Cape Yakataga area. The oil seeps at Cape Yakataga are the last remaining plausible alternative oil sources for the regional background hydrocarbon signature found inside PWS. If the contribution of hydrocarbons from these seeps is shown to be negligible in comparison with coal sources, then definitive criteria for recovery of benthic sediments inside PWS follows immediately, and the link between cytochrome P450 induction and exposure to residual *ExxonValdez* oil is made much stronger.

C. Location

The samples collected for this project will be taken from the coastal and terrestrial margin of the northern GOA between the Duktoth River drainage in the west to Icy Bay in the east. Several short coastal streams bisect the Sullivan syncline in this area and receive oil from seeps associated with the syncline. These samples will be analyzed in Juneau, AK, and in Menlo Park, CA. The benefits of the project will apply most directly to communities and to other Trustee projects in the spill area. The communities that may be directly affected include Cordova, Valdez, and Whittier.

COMMUNITY INVOLVEMENT

Communities will become informed about this project through radio and newspaper interviews responding to agency press releases, which will include communicate significant findings in non-technical language. The necessary vessel and aircraft charters will be advertized in Cordova and in Yakutat, the two communities closest to the study area, but cost will be the primary factor determining selection. Neither traditional nor local knowledge is expected to play a significant part in this project now.

PROJECT DESIGN

A. Objectives

This project has 1 objective:

1. Measure contributions of hydrocarbons from oil seeps and from terrestrial coal deposits to benthic marine sediments adjacent to the northern GOA margin from Icy Bay to the Duktoth River.

B. Methods

Sampling will focus on 6 streams in the Cape Yakataga area, 3 of which receive oil from seeps and 3 of which do not. At each stream, a riparian sediment sample will be collected upstream of any oil seeps (or upstream of the Sullivan syncline an equivalent distance where oil seeps are absent), and just above tidal influence near the stream mouth on the GOA. A marine epibenthic sediment sample will also be collected in front of each stream at a seawater depth of 50 m to characterize the composite sediment discharge of the area.

Each sediment sample will be subjected to a high-density brine solution (CsCl2) to separate coal particles from the remainder of the sediment. Coals in this region have a density of about 1.2, compared with densities above 1.8 for the remaining inorganic fraction of these sediments, and these can be easily separated with brines of intermediate density. Each fraction will be analyzed for alkane and polycyclic aromatic hydrocarbons (PAH; analysis at ABL), and for hydrocarbon biomarkers (analysis at USGS). These analytes will also be determined in the benthic sediment sample without brine separation to compare the hydrocarbon concentrations found in the separated samples with the original samples.

Water samples will also be collected from each of the study streams to evaluate the flux of hydrocarbons from oil seeps into the GOA. A 4 L water sample will be collected 100 m downstream of the oil seep entry point into a stream (or an equivalent distance upstream when oil seeps are absent), and another 4L water sample will be collected just above tidal influence near the stream mouth on the GOA. Each water sample will be partitioned into a dissolved and particulate fraction as describe by Payne et al. (International Oil Spill Conference, 1999). The dissolved and particulate water sample fractions will also be analyzed for alkane, PAH and biomarker hydrocarbons as described above for sediments.

Analysis of sediment samples for PAH will follow methods described by Short et al. (American Fisheries Society Symposium 18, pp.140-148, 1996). Biomarker analysis is summarized by Carlson et al. (U.S. Geological Survey Open File Report 97-518, 1997).

By physically separating the coal particles from these sediments, the contribution estimate from this source will be quite unambiguous. Comparison of dissolved and particle-bound hydrocarbons in the water samples together with stream discharge estimates will further constrain contributions from oil seeps. Hydrocarbon pattern recognition will follow methods summarized by Short et al. (Environmental Science & Technology, Vol 33, pp. 34-42, 1999).

C. Contracts and Other Agency Assistance

The U.S. Geological Survey will cooperate with this project. Their participation is necessary because they have the expertise required to perform the brine density separations of the sediment samples, and the analysis of the samples for hydrocarbon biomarkers.

Collection and partitioning of the water samples will be contracted to Payne Environmental Consultants, who have developed the sample fractionation methodology to be used.

SCHEDULE

A. Measurable Project Tasks for FY00

FY00:

Apr 15 - June 30: Collect sediment and water samples.

Jun 1 - Sep 30: Analyze samples for hydrocarbons

B. Project Milestones and Endpoints

Finish sample collection by June 30, 2000 (this is weather-dependent).

Finish sample processing and hydrocarbon analysis by Sept. 30, 2000

Complete final report and submit manuscript for publication in peer-reviewed journal by Apr 15, 2001.

C. Completion Date

April 15, 2001

PUBLICATIONS AND REPORTS

A final report will be produced by April 15, 2001. A manuscript will be submitted for publication in peer-reviewed journal by Apr 15, 2001.

NORMAL AGENCY MANAGEMENT

If the oil spill had not occurred, neither NOAA nor USGS would be conducting this project.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will complete work funded under Trustee project 290 in previous years to identify and interpret hydrocarbon signals in the oil spill region.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

None

PROPOSED PRINCIPAL INVESTIGATOR

Jeffrey W. Short
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National Marine Fisheries Service, NOAA
11305 Glacier Highway, Juneau, Alaska 99801-8626
Phone: (907) 789-6065
FAX: (907) 789-6094
e-mail: jeff.short@noaa.gov

PRINCIPAL INVESTIGATORS

1. Jeffrey W. Short (Sediment sample collection; PAH analysis and interpretation)

Education: M.S. (Physical Chemistry)

Relevant Experience:
1989- Present: Established and managed the hydrocarbon analysis facility at ABL to analyze hydrocarbon samples generated by the *Exxon Valdez* NRDA effort (about 20% of these samples were analyzed at ABL).
1989 - 1992: Principal Investigator, Exxon Valdez project Air/Water #3: Determination of petroleum hydrocarbons in seawater by direct chemical analysis and through the use of caged mussels deployed along the path of the oil spill.
1991 - 1996: Principal Investigator, Exxon Valdez project Subtidal #8: Development of computer-based statistical methods for global examination of sediment and mussel hydrocarbon data produced for the Exxon Valdez NRDA effort for systematic bias, and for identification of probable sources of hydrocarbons.
1996 - present: Principal Investigator, Restoration Project 290, Database Management: Discovered particulate coal on beaches near Katalla is a major source of background PAH in marine sediments of the spill area.

2. Keith A. Kvenvolden (Sediment sample collection and partitioning; hydrocarbon biomarker analysis; biomarker and geochemistry interpretation)

Education : Ph. D. (Geology)

Relevant Experience:

Group Leader, Organic Geochemistry
Branch of Pacific Marine Geology
U. S. Geological Survey
Menlo Park, CA

Over 250 peer-reviewed scientific publications on hydrocarbons in the marine environment

3. James R. Payne (Water sample collection and partitioning, interpretation of aqueous hydrocarbon results)

Education: Ph. D (Chemistry)

Relevant Experience:

Author of 4 books and 27 peer-reviewed scientific publications on effects of water-borne hydrocarbon pollutants.

2000 EXXON VALDEZ TRI COUNCIL PROJECT BUDGET

October 1, 19[illegible] - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000	PROPOSED FY 2000 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
							$30.8	$66.0
Personnel	$0.0	$43.6						
Travel	$0.0	$10.1						
Contractual	$0.0	$25.5						
Commodities	$0.0	$6.6						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$85.8			Estimated FY 2001	Estimated FY 2002		
General Administration	$0.0	$8.3						
Project Total	$0.0	$94.1			$10.0	$3.0		
Full-time Equivalents (FTE)	0.0	0.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$46.2			$0.0	$0.0		

Comments:

Total NOAA Contribution: 33K
Total USGS Contribution: 13.2K for a total contribution of 42,6K

FY00

Prepared: 4/13/99

Project Number: 00599
Project Title: Evaluation of Yakataga Oil Seeps as Regional Back ground Hydrocarbon Sources in Benthic Sediments of EVOS Area
Lead Agency: National Oceanic & Atmospheric Administration

FORM 2A
MULTI-TRUSTEE
AGENCY SUMMARY

2000 EXXON VALDEZ TRI COUNCIL PROJECT BUDGET

October 1, 19[illegible] - [illegible]eptember 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$30.4
Travel		$6.7
Contractual		$22.5
Commodities		$6.6
Equipment		$0.0
Subtotal	$0.0	$66.2
General Administration		$6.1
Project Total	$0.0	$72.3
Full-time Equivalents (FTE)		0.4
Other Resources		$33.0

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		$10.0	$3.0		

Dollar amounts are shown in thousands of dollars.

Comments:

NOAA Contribution:
Senior Research Chemist, P-I Jeff Short 1.5 mo.@ 14.1K, Senior Analytical Chemist Marie Larsen 1 mo @ 6.7K , Program Manager, Stan Rice 1 mo @ 12.2K for a total NOAA contribution of:33K.

FY00

Prepared: 4/13/99

Project Number:
Project Title: Evaluation of Yakataga Oil Seeps as Regional Background Hydrocarbon Sources in Benthic Sediments of EVOS Area
Lead Agency: National Oceanic & Atmospheric Administration

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRI 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 Short	Senior Research Chemist	13/4	0.5	9.3		4.7
Marie Larsen	Research Chemist	11/6	0.5	6.6		3.3
Chemistry Lab Analyses Preparation						0.0
Josie Lunasin	Chemist	9/6	4.0	5.6		22.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		5.0	21.5	0.0	
					Personnel Total	$30.4

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
					0.0
Juneau to Anchorage -Resoration Workshop	0.4	2	4	0.2	1.6
(Misc. car rental, telephone POV mileage etc).					0.0
					0.0
Juneau- Yakutat-Juneau	0.6	1	10	0.2	2.6
					0.0
Helicopter charter for 1 day	2.5	1	1		2.5
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$6.7

FY00

Prepared: 4/13/99

Project Number:
Project Title: Evaluation of Yakataga Oil Seeps as Regional Background Hydrocarbon Sources in Benthic Sediments of EVOS Area
Lead Agency: National Oceanic & Atmospheric Administration

FORM 3B Personnel & Travel DETAIL

Contractual Costs:	Proposed
Description	FY 2000
Boat Charter - 1 seiner for 5 days at 1.5K/day	7.5
Contract chemistry lab labor, 2.0months at 2.5K/mo	5.0
Payne Environmental Consultants- collection and partition of water samples	10.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$22.5

Commodities Costs:	Proposed
Description	FY 2000
Chemistry lab supplies for analyses (chemicals and glassware)	6.0
Paage Charges	0.6
Commodities Total	$6.6

FY00

Prepared: 4/13/99

Project Number:
Project Title: Evaluation of Yakataga Oil Seeps as Regional Background Hydrocarbon Sources in Benthic Sediments of EVOS Area
Lead Agency: National Oceanic & Atmospheric Administration

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		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
GC/MS		NOAA
HPLC		NOAA

FY00

Prepared: 4/13/99

Project Number:
Project Title: Evaluation of Yakataga Oil Seeps as Regional Background Hydrocarbon Sources in Benthic Sediments of EVOS Area
Lead Agency: National Oceanic & Atmospheric Administration

FORM 3B Equipment DETAIL

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

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$13.2
Travel		$3.4
Contractual		$3.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$19.6
General Administration		$2.2
Project Total	$0.0	$21.8
Full-time Equivalents (FTE)		0.1
Other Resources		$13.2

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		

Dollar amounts are shown in thousands of dollars.

Comments:
USGS Contribution: K.Kvenvolden, Group Leader Chemist, 1.0 mo @ 13.2K for a total USGS contribution of 13.2K

FY00

Prepared: 4/13/99

Project Number:
Project Title: Evaluation of Yakataga Oil Seeps as Regional Background Hydrocarbon Sources in Benthic Sediments of EVOS Area
Agency: DOI- USGS

FORM 3A TRUSTEE AGENCY SUMMARY

2000 EXXON VALDEZ TRU :OUNCIL PROJECT BUDGET

October 1, 199s - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
Keith Kvenvolden	Group Leader, Organic Geochemistry	GS-14	1.0	13.2		13.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.0	13.2	0.0	
					Personnel Total	$13.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
Menlo Park - Yakutat for sampling	0.7	2	10	0.2	3.4
for USGS personnel					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	$3.4

FY00

Prepared: 4/13/99

Project Number:
Project Title: Evaluation of Yakataga Oil Seeps as Regional Background Hydrocarbon Sources in Benthic Sediments of EVOS Area
Agency: DOI- USGS

FORM 3B Personnel & Travel DETAIL

Contractual Costs:		Proposed FY 2000
Description		
Chemistry Lab supplies		3.0
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$3.0

Commodities Costs:		Proposed FY 2000
Description		
	Commodities Total	$0.0

FY00

Prepared: 4/13/99

Project Number:
Project Title: Evaluation of Yakataga Oil Seeps as Regional Background Hydrocarbon Sources in Benthic Sediments of EVOS Area
Lead Agency: National Oceanic & Atmospheric Administration

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
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Chemistry Laboratory		

FY00

Project Number:
Project Title: Evaluation of Yakataga Oil Seeps as Regional Background Hydrocarbon Sources in Benthic Sediments of EVOS Area
Agency: DOI- USGS

FORM 3B Equipment DETAIL

Prepared: 4/13/99

4-15 file

Kodiak Island Youth Area Watch

Project Number:	00610
Restoration Category:	General Restoration
Proposer:	Chugach Regional Resources Commission
Lead Trustee Agency:	ADFG
Cooperating Agency:	Kodiak Island Borough School District
Alaska SeaLife Center:	Yes
Duration:	1st year, 3-year project
Cost FY 00:	$101.5
Cost FY 01:	$101.5
Cost FY 02:	$101.5
Geographic Area:	Kodiak Island
Injured Resources/Services:	Harbor seals, sub-tidal and inter-tidal communities, subsistence, and commercial fishing

ABSTRACT

In FY 99, Chugach Regional Resources Commission collaborated with the Kodiak Island Borough School District to institute an internship program within the Community Involvement Project. This internship program choose one student in the communities of Akhiok, Larsen Bay, Old Harbor, Port Lions, Kodiak and Karluk. These students participated in the 10-Year Symposium, disseminated scientific information to their school and community, and completed individual projects that focus on the science program of the Trustee Council.

This project would expand the involvement and objectives of the internship program by doing the following: collaborating with four research projects on Kodiak Island, which include 00482, PSP Field Testing Kit; 00245, Harbor Seal Biosampling; a yet-to-be identified commercial fishing research project with the Fisheries Industrial Technical Center in Kodiak; and finally, an algae testing project with Dr. Gerry Plumley, UAF, to find the origin of PSP funded by the Alaska Science and Technology Foundation; each participant will conduct their own community scientifically-based research project that they will design and collaborate with the site teachers, tribes, and researchers that are involved in the program; and finally attend the Restoration Workshop in January 2000 and present results from work performed.

INTRODUCTION

The Youth Area Watch program instituted in the Prince William Sound and lower Cook Inlet has been one of the most popular and supported projects that the Trustee Council has implemented. The spill area does not strictly include only those areas though, but instead encompasses Kodiak Island and the Alaska Peninsula. The villages on Kodiak Island have all seen results from this Youth Area Watch and seen the interest expressed by Kodiak Island youth in the Community Involvement Project Internship Program. It is because of this that the Kodiak Island Borough School District and Chugach Regional Resources Commission have submitted this proposal.

Children in high school will be selected to participate depending on their scholastic skills, interest in science, and ability to commit to the project. This project will encourage youth, primarily Alaska Natives, to participate in the sciences and possibly go on to pursue careers in the science field. It will be a coordinated effort between the school district, CRRC, and tribal councils throughout the Island.

Four core research projects, two of which are funded by the Trustee Council, will be the heart of the program. These project include 00482, Field-Testing of PSP Test Kits for Subsistence Use. This proposal was submitted to the Trustees and if funded will heavily rely on the youth in this project to carry out field tests. Secondly, 00245, Harbor Seal Biosampling, will train and involve Kodiak Island Youth Area Watch participants in the program. They will be trained in how to conduct a biosample, where to ship the sample, and what the uses of the seal are. Third, Dr. Gerry Plumley, University of Alaska-Fairbanks, has received funding from the Alaska Science and Technology Foundation to test algae for a possible connection to the infection of PSP to shellfish. He has indicated that Youth Area Watch participants would play a large role in the formation, implementation, and success of that project. Finally, Dr. Scott Smiley of the Kodiak Fisheries Technology Center has indicated an interest in involving youth in some of the commercial fisheries studies that take place around Kodiak Island.

In addition, students will select a local project to conduct. Possible connections to traditional knowledge, and integrating TEK data into a format traditionally used in western science are an option. Teri Schneider, Cultural Coordinator at the Kodiak Island School District, is very interested in pursuing this integration. It is an option to implement their own small-scale research. It is a hope that this would be presentable at the January 2000 Restoration Workshop.

NEED FOR PROJECT

A. Statement of Problem

Kodiak Island Youth Area Watch would share much of the same values and objectives of that as the original Youth Area Watch. The commitment would be to assist in the restoration of the spill area through the collection and requisite samples and data for principal investigators of research projects. Research dollars are often scarce – the

assistance of labor through this project to the four core projects would be an invaluable asset to the overall restoration effort.

The public aspect of this would also be invaluable to the Trustee Council. Youth involved in science, especially Alaska Natives, has been difficult to achieve in many cases. This project give students hands-on experience and an avenue to achieve goals that may before have seemed impossible. Youth Area Watch has received tremendous support throughout the spill area and beyond and the benefits of this project are felt in many different arenas. The Trustee Council would be supporting a win-win situation by funding this project.

B. Rationale/Link to Restoration

The Kodiak Island Youth Area Watch will work in primarily three areas. First, harbor seals disastrously affected by the oil spill are being studied under 00245. YAW participants would assist in this recovery effort of the Alaska Native Harbor Seal Commission and Trustee Council. Secondly, the enhancement of safe shellfish to eat would benefit the use of subsistence greatly; consequently, assisting in the recovery of the subsistence service by providing a replacement subsistence resource for harvesters. The field test and algae project both will assist in making shellfish safer for everyone. Finally, the Fisheries Technology Center in Kodiak has multiple research projects on commercial fishing in the Kodiak Island region. The willingness of the Center to integrate YAW in one of their projects will assist in the recovery of the commercial fishing service injured by the oil spill.

The public/youth involvement through this project in the restoration process will assist the Trustee Council in their mission to inform and involve the public regarding the restoration program.

C. Location

Kodiak Island Youth Area Watch will take place in the Kodiak Island communities of Akhiok, Old Harbor, Karluk, Larsen Bay, Port Lions, Ouzinkie, and Kodiak. Site teachers will be recruited through the school district and Teri Schneider will serve as the coordinator for the program for the school district. Hugh Short will work with the school district and provide outreach to tribal councils throughout Kodiak Island, utilizing the Community Involvement/Traditional Ecological Knowledge Project. Additionally, TEK will be integrated into the program with the assistance of TEK Specialist, Dr. Henry Huntington.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

In addition to assisting in research, community involvement and the utilization of traditional ecological knowledge are at the heart of this program. Tribal councils, schools, communities, regional organizations, and researchers will all be collaborating to ensure that this project is a success. CRRC will work closely to ensure that each of the

tribal councils where there is YAW participants will have a voice in the research and curriculum of the program. Traditional ecological knowledge will be integrated into the projects that student's design and collaborating researchers will be encouraged to utilize TEK on their particular projects.

PROJECT DESIGN

A. Objectives

Selected students in the identified communities will participate in the project to accomplish the following objectives:

1. Research project personnel interact with students, communities, and staff.
2. Identify all research and data collection activities.
3. Orient researchers on working with students.
4. Conduct research with the four projects.
5. Update MOA between CRRC and KIBSD.
6. Complete site teacher training.
7. Conduct school orientations for student in YAW.
8. Complete student project training with tribal council and site teacher.
9. Facilitate project follow-up training with site teachers.

METHODS

CRRC will update the current sub-contract with the Kodiak Island Borough School District to reflect the expansion of project from the previous years Internship program. Agreements will be made with tribal councils throughout the island to ensure their meaningful involvement in the project. Researchers involved will sign contracts to ensure their follow-through of involving the youth in their projects.

Teri Schneider, Cultural Coordinator with the Kodiak Island Borough School District, and Hugh Short, Community Involvement Coordinator with CRRC, will work cooperatively to plan the involvement and logistics of youth and researchers field work. Additionally, training will take place with all involved parties to ensure that this project will work for everyone.

We will utilize the Chugach School Districts developed tool for selecting applicants for the program. Up to 13 students will be selected in the first year of the project. While distribution may vary according to interest and ability of students that apply, it is expected that the distribution will be as follows: two from Kodiak, two from Old Harbor, two from Larsen Bay, one from Karluk, two from Port Lions, two from Ouzinkie and two from Akhiok.

Prior to the school year in the fall, participating YAW teachers will congregate in Kodiak to conduct a two-day training on what the program will encompass. We will ask that those researchers who are available to attend as well. Since funding will not yet be

available, CRRC will front the cost of this training. Protocols from principal investigators and program details will be discussed. In addition to the site teachers, we will invite tribal council representatives.

Three of the coordinating projects, field test PSP kit, algae testing, and biosampling, will take place geographically close to the participant's communities. It will be the responsibility of the site teacher and participants to determine field schedules. Harbor seal biosampling will require two training sessions and coordination with local seal harvesters. The commercial fishing project will require coordinated efforts on contracted vessels and such. This will be negotiated between the Fish Tech Center and CRRC. Schedules will be determined when appropriate. Quarterly, students and support staff will congregate in Kodiak for a day to discuss progress and evaluate the program. Training will be on going and project objectives will be met.

Ongoing projects will include:

1) PSP Field Testing, 00482 – Jellet Biotek – Dr. Jellet and Dr. Roberts are selecting sites throughout the spill area to field test their PSP testing kit to be used in place of the existing mouse bioassay. Students in this program will test shellfish harvests from their community and coordinate with Jellet Biotek to ensure that the project has the data it needs.
2) Harbor Seal Biosampling, 00245 – Alaska Native Harbor Seal Commission – YAW will work with local harvesters involved in the program to biosample harbor seals caught for subsistence purposes. Mitch Simeonoff, Akhiok, will work with CRRC and the school district to train and involve students.
3) Algal PSP Testing – Dr. Gerry Plumley – University of Alaska Fairbanks – Dr. Plumley will train students in how to test algae in their area for algal PSP infection. This project will provide data to Dr. Plumley regarding where PSP originates.
4) Dr. Scott Smiley – Fisheries Technical Center - This project will involve the commercial fisheries. The exact project has yet to be identified, but a commitment from Dr. Smiley has been received.

In addition to these four core projects, students will work with their tribal council or local site teacher to identify a local research project to implement that is achievable. We will encourage the tribal councils to identify an area of TEK that may be of interest and possibly try to integrate that with western science methods. TEK Specialist Henry Huntington will be called upon to assist in this effort.

School credit for the youths involvement in this project will be strongly sought after. We anticipate allowing credit to those who participate for the whole length of the project. This will encourage more participation and give credibility to the project among site teachers and students who are thinking about apply to the project. It is anticipated that this project will be strongly popular and receive island-wide attention for the tremendous efforts it will accomplish.

COOPERATING AGENCIES

The Chugach Regional Resources Commission will serve as the administering agency for this project and work closely with the Kodiak Island Borough School District to implement the project. CRRC has a positive history with the Alaska Department of Fish and Game and expects to continue that partnership through this project. We will update our current contract with the school district to reflect the new changes to the program and work to coordinate and collaborate on the successful implementation of the project.

CRRC has a history working with tribal councils on Kodiak Island additionally. We implemented and completed the Subsistence Service Assessment with tribal councils on Kodiak Island, hiring many employees directly. We have a strong partnership with the Community Involvement Project and have demonstrated a commitment to involving all Alaska Native organizations in the restoration process.

A partnership would be created with the University of Alaska system at the Fisheries Technical Center and Dr. Smiley will work to integrate his YAW project with the on-going tasks that need to be completed.

SCHEDULE

A. Measurable Project Tasks for FY 00

July 1, 1999 – August 1, 1999	Confirm research and data collection activities
August 15-16, 1999	Site teacher, tribal, and researcher orientation
September 1 – 18, 1999	School site orientations
September 15 – 30, 1999	Students selected
October 15 – 31, 1999	Student orientation and training
November 1, 1999 – July 30, 2000	Students participate in research activities
March 1, 2000	Site teachers send data to project PI
March 1 – 15, 2000	Site teacher follow-up training
June 2000	Project Coordinator sends data to PI
June 2000	Students complete FY 00 projects

On-going activities

October 1999 to July 2000	Students collect shellfish samples for field test
October 1999 to July 2000	Students analyze algae
October 1999 to July 2000	Students conduct harbor seal biosamples
October 1999 to June 2000	Students conduct their local research project
October 199 to October 2000	PI interact and share information with students

B. Project Milestones and Endpoints

October 17, 1999	Students selected
October 30, 1999	Protocol training complete

November 1, 1999	Students conduct project activities
March 1, 2000	Data/samples to PI
June 1, 2000	Data/samples to PI and reports complete

D. Completion Date

Objective identified in the project design will serve as guidelines for community involvement within the civil settlement throughout the life of the restoration effort. It is expected that the YAW will be completed upon termination of the restoration effort.

PUBLICATIONS AND REPORTS

No specific publications are planned at this point.

PROFESSIONAL CONFERENCES

Youth will participate in the Restoration Workshop in January 2000.

NORMAL AGENCY MANAGEMENT

Not applicable.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will work closely with the Community Involvement/Traditional Ecological Knowledge Project (00052) and the Harbor Seal Biosampling Project (00245). If funded, this project will work closely with PSP Field Testing (00482).

PROPOSED PRINCIPAL INVESTIGATOR

Patty Brown-Schwalenberg
Executive Director
Chugach Regional Resources Commission
4201 Tudor Centre Dr., Ste. 300
Anchorage, AK 99508
(907) 562-6647
fax: 562-4939
crrcomm@alaska.net

PRINCIPAL INVESTIGATOR

Patty Brown-Schwalenberg is the Executive Director of Chugach Regional Resources Commission. She maintains all administrative authority over CRRC programs and projects. She has extensive experience in project administration, tribal relations, and managing budgets. Ms. Schwalenberg will be responsible for all expenditures, contracts, and project management.

OTHER KEY PERSONNEL

Hugh Short is the Community Involvement Coordinator with Chugach Regional Resources Commission at the Trustee Council.

Teri Schneider is the Cultural Coordinator with the Kodiak Island Borough School District.

Both have extensive experience in outreach, education, and project coordination.

15 title

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		$94.9
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$94.9
General Administration		$6.6
Project Total	$0.0	$101.5
Full-time Equivalents (FTE)		0.0

LONG RANGE FUNDING REQUIREMENTS	
Estimated FY 2001	Estimated FY 2002
$101.5	$101.5

Dollar amounts are shown in thousands of dollars.

Other Resources

Comments:

FY00

Prepared: 4-12-99

Project Number: 00610
Project Title: Kodiak Island Youth Area Watch
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

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

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

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

FY00

Prepare 12-99

Project Number: 00610
Project Title: Kodiak Island Youth Area Watch
Agency: Alaska Department of Fish and Game

FORM 3B
Personnel
& Travel
DETAIL

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

Contractual Costs:	Proposed
Description	FY 2000
Contract with Chugach Regional Resources Commission	94.9
	0.0
	0.0
When a non-trustee organization is used, the form 4A is required. Contractual Total	$94.9

Commodities Costs:	Proposed
Description	FY 2000
Commodities Total	$0.0

FY00

Prepared: 4-12-99

Project Number: 00610
Project Title: Kodiak Island Youth Area Watch
Agency: Alaska Department of Fish and Game

FORM 3B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRUSTEE 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	Inventory Agency

FY00

Project Number: 00610
Project Title: Kodiak Island Youth Area Watch
Agency: Alaska Department of Fish and Game

FORM 3B
Equipment
DETAIL

Prepared: 4-12-99

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

Budget Category:	Authorized FY 1999	Proposed FY 2000	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$12.0						
Travel		$18.9						
Contractual		$45.5						
Commodities		$0.0						
Equipment		$0.0						
Subtotal	$0.0	$76.4			Estimated FY 2001	Estimated FY 2002		
Indirect		$18.5						
Project Total	$0.0	$94.9			$94.9	$94.9		
Full-time Equivalents (FTE)		0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY00

Prepared: 4-12-99

Project Number: 00610
Project Title: Kodiak Island Youth Area Watch
Name: Chugach Regional Resources Commission

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
	Hugh Short	Community Involvement Coordinator	1.5	4.1	0.0	6.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	1.5	4.1	0.0	
					Personnel Total	$6.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2000
	Village - Kodiak - Anchorage (Restoration Workshop) 6 communities	0.5	16	45	0.0	8.0
	Kodiak - Akhiok	0.1	3	3	0.1	0.6
	Kodiak - Old Harbor	0.1	3	3	0.1	0.6
	Kodiak - Ouzinkie	0.1	3	3	0.1	0.6
	Kodiak - Larsen Bay	0.1	3	3	0.1	0.6
	Kodiak - Port Lions	0.1	3	3	0.1	0.6
	Kodiak - Karluk	0.1	3	3	0.1	0.6
	Anchorage - Kodiak	0.3	3	8	0.1	1.7
	Miscellaneaous	0.2	2	2	0.1	0.6
						0.0
						5.0
						0.0
					Travel Total	$18.9

FY00

Prepared: 4-12-99

Project Number: 00052
Project Title: Community Involvement/Traditional Ecological Knowledge
Name: Chugach Regional Resources Commission

FORM 4B
Personnel
& Travel
DETAIL

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

Contractual Costs:	
Description	Proposed FY 2000
Contract with Kodiak Island Borough School District to provide services below 1 coordinator staff - Teri Schneider at $25.0 stipends for site coordinators at $5.0 travel for school district administration at $4.0 contract with vessel at $10.0 commodities at $1.5 project administration at $6.0	51.5
Contractual Total	$51.5

Commodities Costs:	
Description	Proposed FY 2000
Commodities Total	$0.0

FY00

Prepared: 4-12-99

Project Number: 00610
Project Title: Kodiak Island Youth Area Watch
Name: Chugach Regional Resources Commission

FORM 4B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRUSTEE 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	

FY00

Prepa 4-12-99

Project Number: 00610
Project Title: Kodiak Island Youth Area Watch
Name: Chugach Regional Resources Commission

FORM 4B
Equipment
DETAIL

PWS/Kodiak/Lower Cook Inlet Waste Management Community Awareness Video And Community Waste Management Resource Guide

Project Number:	00615
Restoration Category:	General Restoration
Proposer:	Prince William Sound Economic Development Council
Lead Trustee Agency:	
Cooperating Agencies:	
Alaska SeaLife Center:	No
Duration:	1st year, 1-year project
Cost FY 00:	$55,900
Cost FY 01:	$0
Cost FY 02:	$0
Cost FY 03:	$0
Geographic Area:	Prince William Sound, Kodiak Island and Lower Cook Inlet
Injured Resource/Service:	Intertidal and subtidal organisms, salmon and herring eggs, harlequin ducks, black oystercatchers, sea otters, harbor seals, and other seabirds, shorebirds, and marine mammals. The services most likely to benefit are subsistence and recreations, both of which are affected by the adverse environmental and visual effects of pollution.

ABSTRACT

This project will develop a community awareness video and printed waste handling guide to facilitate implementation of the Prince William Sound, Kodiak Island Borough, and Lower Cook Inlet Waste Management Plans. The need for a community pollution program that educates villagers on proper handling of waste materials and promotes use of new EnVironmental Operations Stations is a logical extension of the PWS/Kodiak/Lower Cook Inlet waste management plans funded, in part, by the *Exxon Valdez* Oil Spill Trustee Council.

INTRODUCTION

In FY 97-98, the Prince William Sound Economic Development Council (PWSEDC) implemented the construction of EnVironmental Operation Stations (EVOS) in the 5 communities of the Sound: Cordova, Chenega, Tatitlek, Whittier and Valdez. In addition, PWSEDC assisted in creating a comprehensive used oil management system in each community.

Each PWS community received EVOS buildings which met their specific needs, and were built with demographics and infrastructure of each community in mind. While the larger towns of Cordova, Valdez and Whittier have more people trained to handle hazardous waste, etc., the villages of Chenega Bay and Tatitlek are isolated and have limited opportunities to learn about the ramifications of improper hazardous waste disposal and methods to reduce marine pollution in their communities, including new disposal stations.

In FY 97-98, the Kodiak Island Borough in conjunction with the Kodiak Area Native Association produced a waste management plan. They are currently working to implement the building of similar used oil and hazardous waste stations in each village on Kodiak Island..

In their Master Plan for Waste Management, the Kodiak Island Borough state that the six remote coastal villages on Kodiak Island lack much of the basic community awareness that is needed to dispose of oil and hazardous waste properly. Furthermore, those communities on the road system still face issues related to certain waste streams, including used oil and wastewater sludge.

The villages in Lower Cook Inlet have similar waste management problems and are working to build hazardous waste stations in each of their villages also.

The proposed community awareness video, with accompanying "Community Waste Management Resource Guide", will help ensure that the goal of each waste management plan is achieved by reducing marine pollution that may be slowing the recovery of oil spill-affected species and habitats. In addition, a "Community Waste Management Resource Guide" will be provided to each household use - an easy reference for safe and proper handling of all types of household and other hazardous waste materials.

NEED FOR THE PROJECT

A. Statement of Problem

Studies have shown that 80% of marine pollution is generated by land-based sources (United Nations, 1995). According to NOAA scientist Jeff Short waste oil

has been shown to be much more toxic in marine systems than crude oil. Refined oil goes through a distillation process which increases concentrations of more toxic polynuclear aromatic hydrocarbons (PAH's) similar to what happens with weathered crude oil. Waste oil is even more toxic as it contains combustion-synthesized PAH's from piston ring blow-by. As NMFS studies supported by the *Exxon Valdez* Oil Spill Trustee Council have discovered, very low concentrations of PAH's can cause pink salmon embryo mortalities and Pacific herring larval mortalities and genetic damage [1] [2]. Pollution in Prince William Sound, in the waters surrounding Kodiak Island, and in Lower Cook Inlet affects the following injured resources: intertidal and subtidal organisms, salmon and herring eggs, harlequin ducks, black oystercatchers, sea otters, harbor seals, and other seabirds, shorebirds, and marine mammals.

In both areas, the services most likely affected are subsistence, recreation, and possibly commercial fishing, all of which are influenced by the adverse environmental and visual effects of pollution.

The waste management plans and used oil stations address pollution entering Prince William Sound and the waters around Kodiak Island from a variety of community-based sources, including households, businesses, boats and automobiles. These sources generate used oil, oily bilge water, hazardous wastes, and solid wastes on an on-going basis.

The used oil stations will provide a facility for the villagers to bring their used oil and hazardous waste material. However, unless those using the facility are informed about the environmental impacts of hazardous wastes, instructed on how to use these facilities, and how to handle hazardous material, the stations will be of little use.

Awareness videos for workers in the EVOS buildings plus a "Community Waste Management Resource Guide" for each household will help villagers change habits to break the cycle of pollution by demonstrating examples of improper disposal in villages, on boats and in the wilderness, and establish policies for disposal of waste for home and boats. They will promote regular use of EVOS stations and proper handling of hazardous wastes.

B. Rationale/Link to Restoration

The waste streams generated within communities and which are entering the waters in Prince William Sound, the waters around Kodiak Island, and Lower Cook Inlet on an ongoing basis are affecting fish, wildlife and human uses injured by the spill, including the disruption of important habitat. Any decrease in local pollution would have the effect of reducing the stress on injured fish and wildlife that rely on clean water. The fish and wildlife likely to benefit the most are those

that feed and spawn in the intertidal or near-shore waters in the vicinity of community waterfronts and small boat harbors. The people most likely to benefit are subsistence and recreation users, and possibly commercial fishermen. All of them are affected by the recognition of pollution.

Chronic pollution from community sources is believed to have significant adverse effects on the marine environment:

- refined petroleum products tend to be even more toxic to fish and wildlife than crude oil;
- the cumulative effects of chronic marine pollution can substantially increase the stress on fish and wildlife resources; and
- with regard to the mortality of seabirds, chronic marine pollution is believed to be at as important as large-scale oil spills

Implementation of this project will be further assurance that marine pollution from communities does not further degrade the marine habitat of Prince William Sound, Kodiak and Lower Cook Inlet waters. By assuring that wastes in all households are properly handled and do not contaminate the marine environment, natural recovery of the resources and services will continue without interference.

C. Location

The video will be shot on location at the EnVironmental Operation Station and in the area surrounding Tatitlek. The video, along with enough resource guides for each household, will be distributed to each community. The communities on Kodiak include; Akhiok, Karluk, Larsen Bay, Old Harbor, Ouzinkie, Port Lions and Chiniak. The villages in Prince William Sound will include Chenega Bay and Tatitlek. The communities in Lower Cook Inlet are Nanwalek, Port Graham and Seldovia.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The same representatives from each community that were involved in the waste oil stations in Prince William Sound, Kodiak Island and Lower Cook Inlet will be liaisons for this project.

These liaisons will be our link to each community to explore traditional methods of handling waste and to assist in relaying information about lifestyles and problems they face in disposing of wastes in their communities.

PROJECT DESIGN

A. Objectives

1. Produce a community awareness video to facilitate implementation of the Prince William Sound, the Kodiak Island Borough, and Lower Cook Inlet Master Waste Management plans.

2. To produce a resource guide to be distributed to every household in participating villages which will contain all the material covered in the video, plus additional background and resource information, including a comprehensive guide to proper handling of wastes.

B. Methods

Production of the video and "Community Waste Management Resource Guide" will be a partnership effort involving the Prince William Sound Economic Development Council (project manager), Wild North Productions (producer), and various consultants including Philip Services Corporation, the ADEC, and the Kodiak Island Borough.

The video will be shot on location in and around the village of Tatitlek. The video will clearly demonstrate the need to address the marine pollution problem, and the importance of adopting new techniques and habits to reduce or eliminate that pollution. Methods used to accomplish these goals include using local people to set examples on how new techniques and habits can be incorporated into everyday life: at home, on boats or in the wilderness. Once viewers can picture themselves doing what they see on the screen, they will be quicker to adopt new ways of handling waste materials.

The written "Community Waste Management Resource Guide", will contain all the material covered in the video, plus additional background and resource information, and answers to frequently asked questions. The key component will be a comprehensive guide to proper handling and disposal of solid waste at home, in landfills, on the boat, and at the used oil stations. Safe handling of hazardous waste materials will be addressed in detail as well. The resource guide will be written and edited by Josie Hartwell, the healthcare, environment and safety editor for Business News Alaska.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

We believe that ADEC will be our Lead Agency for this project. We will cooperate fully with any other agencies that are found to be helpful or necessary to this project.

SCHEDULE

A. Measurable Project Tasks for FY 00

Oct. 1 - April 30:	Initial project meetings. Video pre-production including research and script development to rough draft.
May 1 - June 15:	Video Production, Prince William Sound
June 16 - Aug. 31:	Video post-production. "Community Waste Management Resource Guide" completed and printed. Both products delivered to Prince William Sound Economic Development Council
Sept. 1 - 20 2000:	Distribution of product and public meetings.

Payment Schedule:

October 1, 1999:	One-third of projected costs
June 15, 2000:	One-third of projected costs or upon completion of all shooting
September 30, 2000:	One third of projected costs

B. Project Milestones and Endpoints

Both of the objectives described in this proposal will be fully completed at the end of FY 00 (October 2000). Project milestones are described in the following schedule.

Oct. 1 - April 30:	Research and script development for video and rough draft of resource guide complete.
May 1 - June 15:	Complete video image capture.
June 16 - Aug. 31:	Video and "Community Waste Management Resource Guide" completed and delivered to Prince William Sound Economic Development Council.
Sept. 1 - 30:	Prince William Sound Economic Development council to coordinate public meetings, and to distribute videos and resource guides to all communities.

C. Completion Date

The entire project will be completed by September 30, 2000 (FY 00). This includes the distribution of all videos and resource guides and any public meetings.

PUBLICATIONS AND REPORTS

The first, and final report for this project will be submitted in September 2000.

PROFESSIONAL CONFERENCES

No conferences are scheduled.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project is a natural extension of the used oil stations in Prince William Sound, the Kodiak Island Borough and Lower Cook Inlet. The SWMPII project in Prince William Sound was completed in April 1998 and construction of the used oil stations on Kodiak Island will begin in the next year. Prince William Sound Economic Development Council will coordinate with the engineers and parties involved in these projects to assure the video and resource guide meet the needs of the communities. Philip Services Corp. (PSC) will provide technical assistance in the development of the video and printed "Community Waste Management Resource Guide".

PROPOSED PRINCIPAL INVESTIGATORS

Kara Merrell
Prince William Sound Economic Development Council
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Wild North Productions
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PRINCIPAL INVESTIGATORS

Kevin Hartwell is an Alaskan filmmaker who has been producing compelling documentary television programs and videos for over 15 years. His work has been seen on every major broadcast and cable network, earning numerous

awards at state, national and international levels. Hartwell recently completed two documentaries about the 10-year recovery status following the Exxon Valdez Oil spill, including Legacy of an Oil Spill, produced under contract for the *Exxon Valdez* Oil Spill Trustee Council. Having spent two years in the field working with researchers, Native communities, fisherman, RCAC and state and federal agencies in the spill region, Hartwell is knowledgeable in a wide range of issues still facing injured resources and services in the spill region.

Kara Merrell received a BA in Economic and International Relations from Trinity College, Washington D.C. in 1995. She has experience with project management through her involvement with the management of the EVOS stations in Prince William Sound, the Valdez Duck Flats and the Tatitlek Coho Release program.

OTHER KEY PERSONNEL

Tim Law, PE, Philip Services Corp.
Ben Knight, Environmental Specialist, Kodiak Island Borough

LITERATURE CITED

1. Carl MG, Short JW, Rice SD. 1998 Sensitivity of fish embryos to weathered crude oil: Part I. Low-level exposure during incubation causes malformations, genetic damage, and mortality in larval Pacific herring (clupea pallasi). National Marine Fisheries Service, NOAA, Auke Bay Laboratory

2. Heintz RA, Hose JE, rice SD. 1998. Sensitivity of fish embryos to weathered crude oil: Part II. Increased mortality of pink salmon (oncorhynchus gorbuscha) embryos incubating downstream from weathered Exxon Valdez crude oil. National Marine Fisheries Service, NOAA, Auke Bay Laboratory

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

Budget Category:	Authorized FY 1998	Proposed FY 1999	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$0.0						
Travel		$0.0						
Contractual		$55.9						
Commodities		$0.0						
Equipment		$0.0						
Subtotal	$0.0	$55.9		Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
General Administration		$3.9						
Project Total	$0.0	$59.8						
Full-time Equivalents (FTE)		0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY 99

Prepared:

Project Number: 00615
Project Title:
Agency:

FORM 3A
TRUSTEE
AGENCY
SUMMARY

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

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

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

FY 99

Prepared:

Project Number:
Project Title:
Agency:

FORM 3B
Personnel
& Travel
DETAIL

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

Contractual Costs:		Proposed
Description		FY 1999
4A Linkage		55.9
When a non-trustee organization is used, the form 4A is required.	Contractual Total	$55.9

Commodities Costs:		Proposed
Description		FY 1999
	Commodities Total	$0.0

FY 99

Prepared:

Project Number:
Project Title:
Agency:

FORM 3B
Contractual &
Commodities
DETAIL

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

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

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY 99

Prepared:

Project Number:
Project Title:
Agency:

FORM 3B
Equipment
DETAIL

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

Budget Category:	Authorized FY 1998	Proposed FY 1999	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$0.0						
Travel		$3.9						
Contractual		$52.0						
Commodities		$0.0						
Equipment		$0.0						
Subtotal	$0.0	$55.9		Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
Indirect								
Project Total	$0.0	$55.9						
Full-time Equivalents (FTE)		0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY 00

Prepared: 4/12/99

Project Number:
Project Title: PWS/Kodiak/Lower Cook Inlet Waste Management Community Awareness Video and Community Waste Management Resource Guide
Name: Prince William Sound Economic Development Council

FORM 4A
Non-Trustee
SUMMARY

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

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 1999
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	0.0	0.0	0.0	
					Personnel Total	

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 1999
Travel from Anchorage to Tatitlek	producer	1.0	1		0.0	1.0
						0.0
Travel from Anchorage to Tatitlek	crew	1.0	1			1.0
						0.0
Travel from Anchorage to Tatitlek	crew	1.0	1			1.0
						0.0
Total per diem (6 daysx x3 crew members x $50 per day)						0.9
						0.0
						0.0
					Travel Total	$3.9

FY 00

Prepared: 4/12/99

Project Number:
Project Title: PWS/Kodiak/Lower Cook Inlet Waste Management Plan Community Awareness Video and Connunity Waste Management Resource Guide
Name: Prince William Sound Economic Development Council

FORM 4B
Personnel
& Travel
DETAIL

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

Contractual Costs:	Proposed
Description	FY 1999
Image Capture (Tatitlek)	9.0
Production Insurance	0.5
Logging and Computer Video Capture	3.5
Digital Editing Suite/Editor	7.5
Music	0.4
Narrator	0.5
VHS Video Copies	0.3
PWSEDC Project Management (12%)	6.3
Collateral Materians, including training manual	10.0
Phillips Environmental	5.0
Producer/Writer	8.0
Video Stock (Betacam)	1.0
Contractual Total	$52.0

Commodities Costs:	Proposed
Description	FY 1999
Commodities Total	$0.0

FY 00

Prepared: 4/12/99

Project Number:
Project Title: PWS/Kodiak/Lower Cook Inlet Waste Management Community Awareness Video and Community Waste Management Resource Guide
Name: Prince William Sound Economic Development Council

FORM 4B
Contractual & Commodities DETAIL

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

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

Existing Equipment Usage: Description	Number of Units	

FY 99

Prepared: 4/10/98

Project Number:
Project Title: PWS/Kodiak Waste Management Community Awareness Training Video and Manual
Name: Prince William Sound Economic Development Council

FORM 4B
Equipment
DETAIL

Project Title:	**Sound Waste Management Plan: Boat Harbor Sewage System Phase**
Project Number:	00616
Restoration Category:	General Restoration
Proposer:	Prince William Sound Economic Development Council
Lead Trustee Agency:	ADEC
Cooperating Agencies:	
Alaska SeaLife Center:	No
Duration:	FY00 "1st year, l-year project"
Cost FY 00:	$428,000
Cost FY 01:	0
Cost FY 02:	0
Geographic Area:	Prince William Sound
Injured Resource/Service:	All

ABSTRACT

Providing communities the capacity to manage and control pollutants will protect Prince William Sound species and will aid the recovering species affected by the *Exxon Valdez* oil spill Boat harbor pump-out systems will provide seasonal safe sewage management for marine vessels. The systems can be easily activated in winter in case of a natural or man-made emergency. This system will protect the commercial shellfish operations around the sound, as well as the other fish and marine mammal populations recovering from the oil spill.

INTRODUCTION

It is suspected that salmon, a major fish species injured during the oil spill, when out-migrating through the harbors of Chenega Bay, Cordova, Tatitlek and Whittier, suffer when exposed to raw sewage. In turn, these smolt are consumed by other species, such as the common loon, pelagic cormorants, harbor seals and sea otters, still not listed as recovered ten years after the spill. Another example of the danger presented by raw sewage in harbors would be polluted beach areas, a habitat for blue mussels. Blue mussels are a major food source for young sea otters, black oyster catchers, several species of diving ducks, such as harlequin ducks, all affected by the oil spill, and as yet unrecovered.

According to data gathered for the Clean Vessel Act, shellfish as "filter feeders" are especially vulnerable to bacteria from sewage and pass this bacteria on through the food chain. The bacteria also use oxygen and may deplete the water's oxygen level, causing stress to fish and other aquatic animals.

The purpose of this proposal is to construct sewage pump-out stations in the communities of Chenega Bay, Cordova, Tatitlek, and Whittier. This project would help reduce sewage disposal in the entire Prince William Sound. Port Valdez will have a sewage pump-out in operation by May, 1999, setting a standard for southcentral Alaska. This is a crucial issue as more and more pleasure boaters, tourists, "live-aboards" and fishermen spend time in the waters of the sound. The systems must be convenient and easily maintained. The systems cannot be subject to expensive user fees to be successful. Currently, many boats are dumping their sewage into the harbor waters. This is a hazard to not only recovering species affected by the oil spill, but Alaska's human population, as well.

NEED FOR THE PROJECT

A. Statement of Problem

Currently, many boats are dumping their sewage into Prince William Sound harbor waters. Most boats have small holding tanks. Without a convenient place to empty their tanks the waste is often discharged into the harbors. This project will improve water quality and protect all species.

The problem is that as boating populations grow, so does the human waste contribution in popular regions. Only within the past ten years has this problem been addressed in the United States. We have an opportunity, by creating sewage-pumping stations in every port in Prince William Sound, to set a precedent for Alaska and perhaps eventually other areas of the Pacific Rim.

In the original Sound Waste Management Plan for Prince William Sound, the urgency for chemical and hazardous waste clean-up was first and foremost. Now, with increasing traffic and

the new road opening in 2000 from Portage to Whittier, the potential increased environmental hazards from increasing sewage waste are apparent

B. Rational/Link to Restoration

A boat harbor sewage system will diminish stresses for recovering species in Prince William Sound. According to *National Estuary Program Challenges - Nutrient Overloading* published by the EPA, states, "Nutrients such as nitrogen and phosphorus are necessary for growth of plants and animals and support a healthy aquatic ecosystem. In excess, however, nutrients can contribute to fish disease, red or brown tide, algae blooms, and low dissolved oxygen. The condition where dissolved oxygen is less than 2 parts per million is referred to as hypoxia. Many species are likely to die below that level- the level of healthy waters is 5 or 6 parts per mission. Sources of nutrients include point and non-point sources such as sewage treatment plant discharges, stormwater runoff from lawns and agricultural lands, faulty or leaking septic systems, sediment in runoff, animal wastes, atmospheric deposition originating from power plants or vehicles, and groundwater discharges."

It further states, "Excessive nutrients stimulate the growth of algae. As the algae die, they decay and rob the water of oxygen The algae also prevent sunlight from penetrating the water. Fish and shellfish are deprived of oxygen, and underwater seagrasses are deprived of light and are lost. Animals that depend on seagrasses for food or shelter leave the area or die. In addition, the excessive algae growth may result in brown and red tides which have been linked to fish kills, manatee deaths and negative impacts to scallops. Increased alga may also cause foul smells and decreased aesthetic value."

Sewage contamination is measured in terms of fecal coliforms - bacteria produced in the intestines of all warm-blooded animals. Test results are expressed as the number of bacteria per 100 milliliters of water. Shellfish beds are closed to harvesting when the coliform count reaches 14 per 100ml of water. Public beaches are closed to swimmers when the coliform count reaches 200 per 100 ml of water.

Areas most likely to be affected are sheltered waters with low flushing rates, waters with significant recreational value, and areas set aside for shellfish harvesting, (Chenega Bay and Tatitlek farm oysters), State and Federally designated significant habitats such as those in Coastal Zone programs, as well as waters designated by the Environmental Protection Agency as "No Discharge Areas".

Shellfish are filter feeders that eat tiny food particles filtered through their gills into their stomachs, along with bacteria from sewage. Shellfish can convey nearly all water-born pathogens to humans.

C. Location

The project will take place in Chenega Bay, Cordova, Tatitlek and Whittier. The project will benefit the harbors in each town or village, and adjacent waterways entering the harbors, and to some degree, the Gulf of Alaska. It is hoped that Prince William Sound will affect all ports in Alaska, as a prototype in responsible waste management.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

All towns and villages want the sewage pumpout systems in their harbors. All have, or will have soon, letters or resolutions showing their support for the project. The systems should be quite uncomplicated.

The project will protect economic resources in the economically limited communities of Chenega Bay and Tatitlek.

PROJECT DESIGN

Project design will be done by Stephl Engineers, with approval by the various port authorities, Alaska Department of Environmental Conservation and U. S. Coast Guard.

A. Objectives

1. Protect recovering marine resources from further damage due to sewage.

2. This project will ensure that all types of vessels can get their sewage properly dispatched from spring until fall, when 90% of the vessel use will occur.

3. It will be easily activated in the winter months for emergency response efforts for natural catastrophes or other emergencies.

4. It will be supported and maintained by communities and easy to operate.

Boats in Prince William Sound can be separated into four different user groups. Each group of users operates their vessels in a manner and at a schedule that is different from the other users. Each user group has its own unique requirements for convenient sewer service.

Tour Boats The tour boat user group consists of 50' to 100' boats. These boats generally operate full-time from May through September. They each make on the average of one to two trips per day in and out of the harbor during the peak summer operating months. During the winter months these boats operate periodically. The tour boats have sewer holding tanks ranging

in size from 200 to 300 gallons. The tanks have the capacity to hold one day of sewage flow volume. Under normal circumstances, the tanks are emptied each evening when the boats are cleaned, fueled and restocked for the next day's tours.

Transient Boats This group of user generally includes recreational vessels or daily fishing charter vessels from 20' to 60' in length. They operate during the summer months from May through September. Generally, this class of user is traveling in and out of the harbor on the days when they are aboard their vessel. The typical transient vessel is not used for permanent housing in the same manner as a live-aboard vessel. The transient boats typically have sewer holding tanks ranging in size from 30 to 100 gallons. They normally have the opportunity to discharge the holding tank contents when traveling in and out of the harbor.

Fishing Boats The fishing boat user group consists of transient commercial vessels that arrive to harvest the summer fish runs. The fishing boats typically have sewer holding tanks ranging in size from 30 to 100 gallons. Because they are often moored in rafts, they do not have the opportunity to conveniently motor to a pump out station located elsewhere in the harbor.

Live-aboard Boats The boat is often the vessel owners permanent place of residence. These are called live-aboard vessels. Live-aboard vessels occasionally motor in and out of the harbor. The live-aboard boats have sewer holding tanks ranging in size from 30 to 50 gallons. They do not often have the opportunity to conveniently motor to a pump-out station located elsewhere in the harbor.

Emergency Response Efforts In case of an emergency, for instance a tsunami or earth quake or perhaps an oil spill, all of the above can be called upon to aid in relief efforts. Not only would local sound vessels be enlisted but vessels from other ports around Alaska and the northwest, making the sewage systems an even more important part of habitat protection.

B. Methods

Each town or village has specific needs and harbor configurations. There are three main types of sewage pumping systems manufactured for use in boat harbors. A number of manufacturers are building harbor pumping systems today. Many models of pumps, pump-out stations, controls, etc., are available. The recent demand for harbor sewage pumping systems has fueled a growth in this special industry.

A number of options can be considered such as dock mounted pump-outs, mobile pump-out systems with large (300 gallon) tanks mounted in skiffs or specially built self-sufficient floating barges with large holding tanks. The barges are often anchored offshore in the harbors or attached to a dock float.

Chenega Bay Chenega Bay is a community of 80 persons that is located in the southwest portion of Prince William Sound. The town has a small boat harbor with permanent mooring

space for approximately 20 boats. During the salmon season, a large number of fishing boats raft-up to the main float. Most of the vessels permanently moored to the dock are fishing boats. The community recently installed fueling facilities at the harbor. In the near future, they anticipate that more transient vessels will visit the dock to purchase fuel. Chenega Bay has the only fueling station in the southwest part of the sound. The opening of the Portage /Whittier road in 2000 is expected to increase boat traffic immensely.

It is recommended that a permanent pump-out station be installed on the dock and sewage be pumped into the community sewer system. Access to the dock is provided down a relatively steep path to the ramp landing. The community sewer system is approximately 300 feet from the dock and is located approximately 60' above the ramp. A second sewage pump will be needed to overcome the high head. Sewage from the pump-out could be conveyed to the public sewer system via an above ground small diameter flexible line. The pipe would be drained in the winter to prevent freezing. The pump-out system would not operate in the wintertime, unless an emergency occurred.

Cordova Cordova's small boat harbor serves approximately 800 boats. During the peak fishing season from May through September, many fishermen and their crews live on their boats when they are moored in the harbor. The Cordova harbor currently accommodates mainly fishing boats. The harbor has a few transient boats. Tour boats are expected to begin mooring in Cordova in the near future. Cordova does not have any sewage pumping facilities in the small boat harbor at this time.

It is recommended that the Cordova boat harbor could be best served by installing a single pump-out station on a dock float that is centrally located in the harbor. This location would provide easy access for boats coming and going from the launching ramp and can be accessed by the larger fishing tenders and seiners that are 50' or more in length.

Sewage collected in the pump-out station would be conveyed to a city sewer line located nearby in Harbor Drive. The proposed system would consist of a pump-out station, piping along or under the dock, and a second station with adequate capacity to pump sewage uphill to the city sewer line.

Tatitlek Tatitlek currently does not have a small boat harbor. However, they are actively pursuing funding to construct a new harbor. Currently, local fishing boats permanently anchor offshore. Owners and crews travel back and forth to their vessels in skiffs. Boats do have the opportunity to use the ferry dock for temporary moorage when loading or unloading supplies.

Tatitlek's two existing docks present problems for a pumping station mounted on the dock. One dock is exposed to ocean swells, making a secure sewage transfer hazardous. The other dock is dry at low tide, presenting another problem.

A transitional approach is necessary. Sewage collection in Tatitlek can be accomplished with a portable tank mounted in a skiff. This method of sewage collection is very common in other

harbors in the U. S. where permanent docks do not exist. These systems normally include a 300 gallon tank and gas driven pump mounted in an 18' skiff which is powered by an outboard motor. In Tatitlek, the tank would be emptied into the community sewer system via a portable flexible pipe running from the skiff to a nearby manhole. As soon as the new dock is constructed, the tank will be removed from the skiff and mounted on the new dock

Whittier The Whittier boat harbor will experience an unparalleled increase in vessel use within the next few years after the road from Portage is completed. The harbor currently serves fishing boats, tour boats and transient boats. A steep increase in the number of transient boats is expected to occur after the new road opens in 2000. The Whittier harbor does not have sewage pumping facilities at this time.

A logical place to install a pump-out station is at the floating fuel dock. This dock is conveniently located near the harbor entrance. A second option is to install a pump-out station at the end of one of the floats. As with all harbors, dock space is at a premium in Whittier. Sewage collected in the station would be conveyed to a city sewer line located in the uplands area adjacent to the harbor.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Alaska Department of Environmental Conservation will provide environmental leadership. Stephl Engineers was chosen to design and construct these facilities. Contracts will be written and approved by all agencies involved. Project management will be done by Prince William Sound Economic Development Council.

SCHEDULE

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

October 15, 1999 First meetings with all participants to discuss plans, any changes in plans will be made at this time.

December 1, 1999 Approval of finalized plans/building permits from city or IRA Council/review by local Ports and Harbors Commissions/U. S. Coast Guard approval, NEPA approval

September1, 2000, all pumping systems installed and operational.

B. Project Milestones and Endpoints

December 15, 1999 - Installation and training begins in all four communities.
September 1, 2000 - All pumping systems installed and operational.

C. Completion Date - September 1, 2000

PUBLICATIONS AND REPORTS Restoration articles will be offered to various boating magazines, Sunset Magazine' Northwestern life section, various environmental publications.

PROFESSIONAL CONFERENCES Participants will attend *Exxon Valdez* Trustee Council Annual Conference and other required meetings.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project builds on the success of the community based Sound Waste Management Plan previous funded by EVOS, and specifically addresses additional pollutants not mentioned previously.

EXPLANATION OF CHANGES INCONTINUING PROJECTS (N/A)

PROPOSED PRINCIPAL INVVESTIGATOR, IF KNOWN (Unknown)

OTHER KEY PERSONNEL

Marianne See, EVOS Liaison, Office of the Commissioner, Alaska Department of Environmental Conservation, 555 Cordova St., Anchorage, Alaska 99501. (907) 269-7635, FX (907) 269-7508.

Prince William Sound Economic Development Council were project managers on the Chenega Bay Restoration Project, EnVironmental Operating Stations for Prince William Sound communities, and the Valdez Duck Flats Feasibility Study. Sue Cogswell, Executive Director, has twenty years experience in non-profit organizations and construction projects and joined PWSEDC last year. PWSEDC, P. O. Box 2353, Valdez, AK 99686, (907) 835-3775, FX (907) 835-3265.

Matt Stephl is the owner of Stephl Engineers with over 14 years experience in Alaska, (please see attached).

LITERATURE CITED

Sound Waste Management Plan, February, 1996
1992 Clean Water Act
EPA Office of Water, *Challenges Facing Our Estuaries: Key Management Issues*
EPA Office of Water, *Managing Common Estuarine Environmental Problems*

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		$38.4						
Travel		$3.2						
Contractual		$386.4						
Commodities		$0.0						
Equipment		$0.0						
Subtotal	$0.0	$428.0			Estimated FY 2001	Estimated FY 2002		
Indirect								
Project Total	$0.0	$428.0						
Full-time Equivalents (FTE)		2.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY00

Prepared:

Project Number: 00616
Project Title: PWS Boat Harbor Sewer Stations
Name:

FORM 4A
Non-Trustee
SUMMARY

2000 EXXON VALDEZ TR EE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2000
						0.0
	PWSEDC	Project manager	12.0	2.3		27.6
	ADEC	Project manager	12.0	0.9		10.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	24.0	3.2	0.0	
					Personnel Total	$38.4

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2000
						0.0
	PWSEDC project manager from Valdez to Chenega	1.1	1	1	0.0	1.1
	PWSEDC project manager from Valdez to Tatitlek	0.5	1	1	0.0	0.5
	PWSEDC project manager from Valdez to Whittier	0.4	1	1	0.1	0.5
	PWSEDC project manager from Valdez to Cordova	0.4	1	1	0.1	0.5
	PWSEDC project manager from Valdez to Anchorage	0.2	2	2	0.1	0.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$3.2

FY00

Prepared:

Project Number:
Project Title: PWS Boat Harbor Sewer Stations
Name:

FORM 4B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TR...EE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
NEPA Environmental Assessments	15.0
Permits	5.0
Engineering Study and Design	36.0
Construction management	36.1
Construction	214.3
Construction contingency	75.0
Final report	5.0
Contractual Total	$386.4

Commodities Costs:	Proposed
Description	FY 2000
There are no commodities costs in this project	0.0
Commodities Total	$0.0

FY00

Prepared:

Project Number:
Project Title: PWS Boat Harbor Sewer Stations
Name:

FORM 4B
Contractual & Commodities DETAIL

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

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2000
We have included these under contractural costs for construction. It is included in the contractural catagory because the contractor will be responsible for its purchase.			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:
Project Title: PWS Boat Harbor Sewer Stations
Name:

FORM 4B
Equipment
DETAIL

Cordova					
Description	**Quantity**	**Unit**	**Unit Price**	**Subtotal**	
Pump-out station w/controls	1	EA	$21,000	$21,000	
Electrical improvements	1	LS	$5,000	$5,000	
Discharge pipe	500	LF	$40	$20,000	
Uplands sewer pipe	50	LF	$200	$10,000	
Misc. fittings,signs, hoses	1	LS	$3,000	$3,000	
Nonpotable water hose bib	1	EA	$2,000	$2,000	
Subtotal					$61,000
Whittier					
Description	**Quantity**	**Unit**	**Unit Price**	**Subtotal**	
Pump-out station w/controls	1	EA	$21,000	$21,000	
Electrical improvements	1	LS	$5,000	$5,000	
Discharge pipe	700	LF	$40	$28,000	
Uplands sewer pipe	80	LF	$200	$16,000	
Misc. fittings,signs, hoses	1	LS	$3,000	$3,000	
Nonpotable water hose bib	1	EA	$1,500	$1,500	
Subtotal					$74,500
Chenega Bay					
Description	**Quantity**	**Unit**	**Unit Price**	**Subtotal**	
Pump-out station w/controls	1	EA	$21,000	$21,000	
Electrical improvements	1	LS	$4,500	$4,500	
Discharge pipe	300	LF	$40	$12,000	
Uplands above ground sewer	270	LF	$40	$10,800	
Uplands below ground sewer	30	LF	$150	$4,500	
Misc. fittings,signs, hoses	1	LS	$2,000	$2,000	
Nonpotable water hose bib	1	EA	$2,000	$2,000	
Subtotal					$56,800
Tatitlek					
Description	**Quantity**	**Unit**	**Unit Price**	**Subtotal**	
Portable tank and pump	1	EA	$7,000	$7,000	
Outboard motor and skiff	1	EA	$11,000	$11,000	
Flexible discharge hose	100	LF	$20	$2,000	
Misc. fittings, equipment	1	LS	$2,000	$2,000	
Subtotal					$22,000
Subtotal					$214,300
Contingency 35%					$75,005
Subtotal Construction Cost					$289,300
Administration/Engineering 35%					$101,255
Permits and NEPA Documents					$20,000
Final Report and Presentation					$7,000
ADEC Management					$10,000
TOTAL PROJECT COST					$428,000