19.04.03 (2 of 3)

93034

DRAFT EXXON VALDEZ DETAILED PROJECT DESCRIPTION

Project Title: Pigeon Guillemot Colony Survey

Project ID#: 93034

Project Type: Habitat Protection and Acquisition

Project Leaders: Gerald A. Sanger, Principal Investigator
Mary Cody, Associate Investigator

Lead Agency: U. S. Fish and Wildlife Service

Cooperating Agencies: none

Project Cost: FY 93: $165,800; FY 94: $11,200

Start Date: January 1, 1993 **Finish Date:** December 31, 1993

Geographic Area: Prince William Sound

Project Leader: Gerald A. Sanger **Date:** 4/13/93
Gerald A. Sanger

Lead Agency Project Manager: Kenton D. Wohl **Date:** 4-13-93
Kenton D. Wohl

B. Introduction

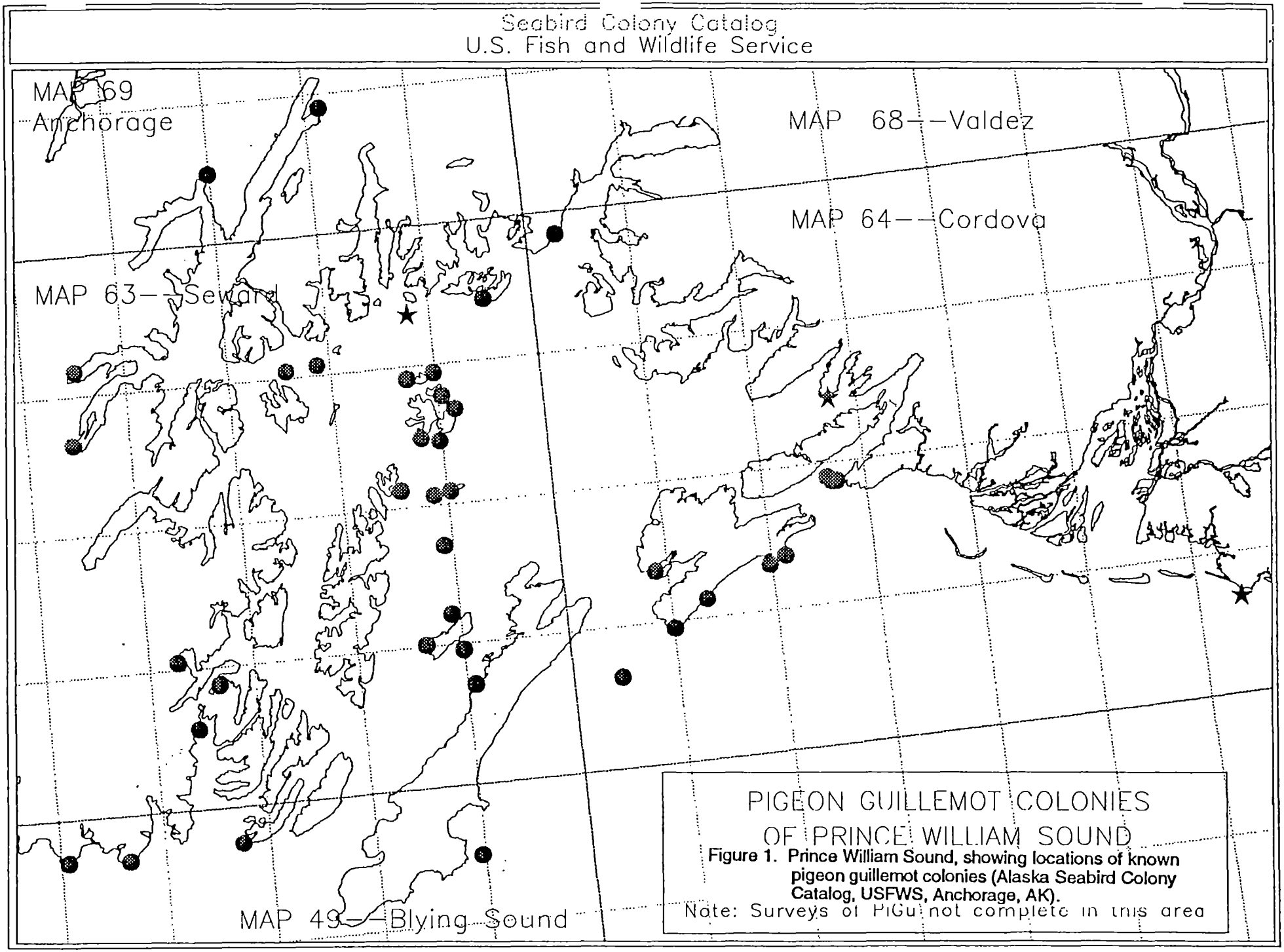
The pigeon guillemot (*Cepphus columba*) is a bantam-sized, diving seabird that nests in rocky coastal habitat throughout the eastern subarctic North Pacific Ocean (Sowls *et. al* 1978). This species feeds mostly in nearshore waters shallower than 20 - 30 m on demersal or epibenthic prey (Kuletz 1983; Sanger 1983; DeGange and Sanger 1986). The U. S. Fish and Wildlife Service began studies of pigeon guillemots at Naked Island, Prince William Sound (PWS), in the late 1970's (Oakley 1981, Kuletz 1983) when oil tankers began moving through the Sound. These studies provided baseline data for assessing the affects of the *Exxon Valdez* oil spill on pigeon guillemots. However, scanty knowledge of colonies in the rest of the Sound hampers assessment of their current status and plans for restoration.

Evidence collected by Bird Study 2 suggests that the PWS population of pigeon guillemot declined since the early 1970's, and it is also one of nine seabird species whose population in the oiled area of PWS declined compared with unoiled areas (Klosiewski and Laing ms). The estimated number of guillemots in the oiled zone of the Sound during March following the spill was 33% lower than expected, a projection based on comparisons with unoiled areas (Klosiewski and Laing ms). A similar population decline was found at Naked Island, where numbers along oiled shorelines showed a more pronounced decline than those along unoiled shorelines (Oakley and Kuletz ms).

Although the locations of some pigeon guillemot colonies are known in PWS (Figure 1), for the most part, the locations and sizes of their colonies in the Sound (and elsewhere in Alaska) are unknown. Most past seabird colony surveys in Alaska (e.g., Sowls *et al* 1978) have focused on large, multi-species colonies. However, since pigeon guillemots represent only a small portion of all birds at these colonies, they have been underestimated or missed altogether.

Of even greater significance is the fact that earlier colony surveys have missed the critical time-tide window when guillemots are most likely to be seen (see below). After the spill, colonies in the oiled shoreline zone were surveyed only at Naked Island in 1989 and 1990 (Oakley and Kuletz ms), and at Afognak Island in 1992 (Cody and Gehrlach 1993). Klosiewski and Laing (ms) estimated the total guillemot population for PWS. However, except for the Naked Island group (Oakley and Kuletz *loc. cit.*), there is no current information on the status of guillemot colonies or breeding populations in the Sound. There have never been any colony surveys specifically for guillemots in other areas of PWS that were hit hard by the spill, e.g., Knight Island.

The present project will benefit restoration of pigeon guillemots in the Sound by providing information on the locations of colonies in areas impacted by the spill (Figure 2). The project will also identify colonies where possible protection or additional oil cleanup may help population recovery.


Seabird Colony Catalog
U.S. Fish and Wildlife Service
MAP 69
Anchorage
MAP 68--Valdez
MAP 64--Cordova
MAP 63--Seward
MAP 49--Blying Sound
PIGEON GUILLEMOT COLONIES
OF PRINCE WILLIAM SOUND
Figure 1. Prince William Sound, showing locations of known pigeon guillemot colonies (Alaska Seabird Colony Catalog, USFWS, Anchorage, AK).
Note: Surveys of PiGu not complete in this area

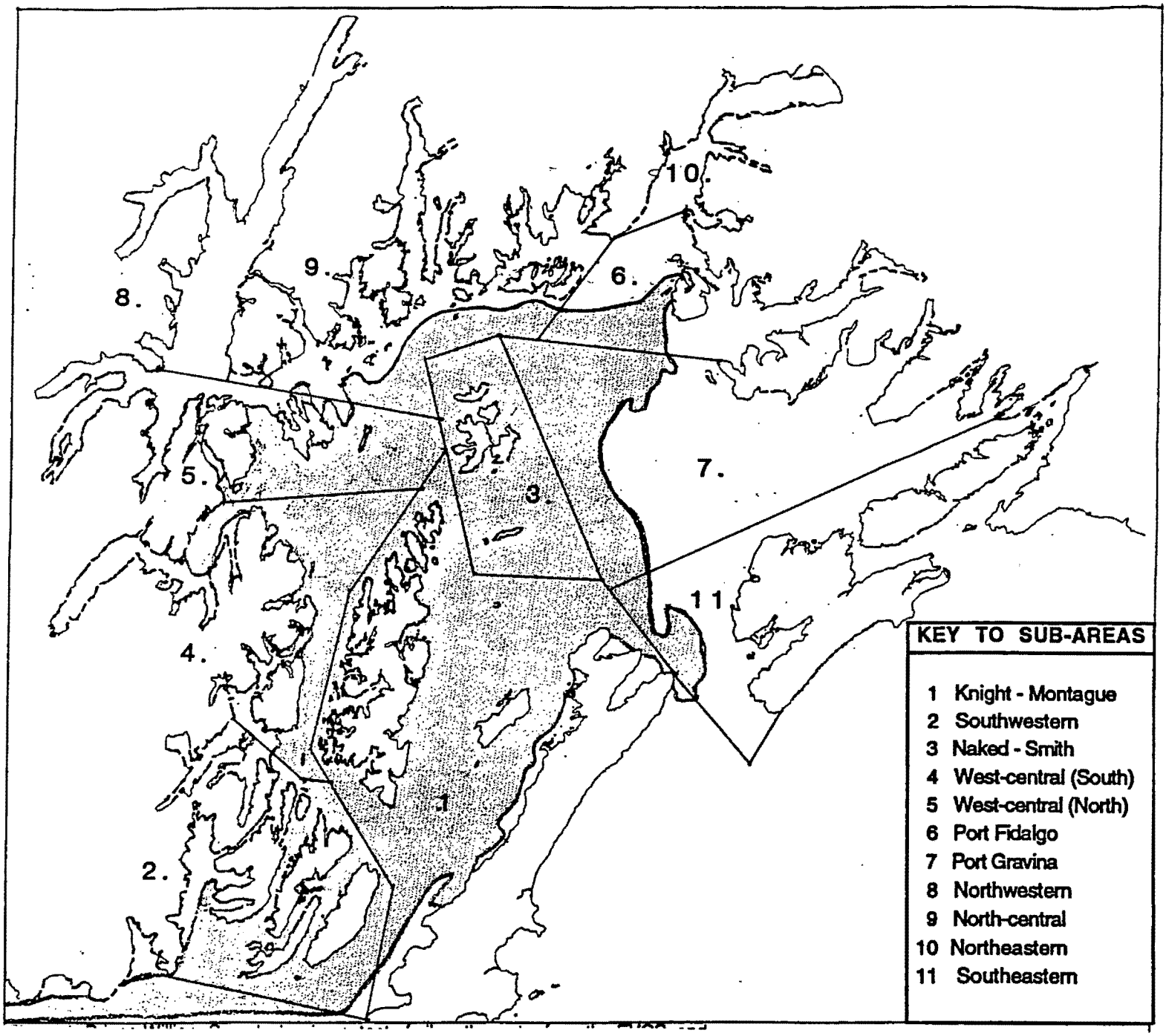


Figure 2. Prince William Sound, showing extent of oil on the water from the spill and subareas where shorelines will be surveyed for pigeon guillemot colonies. See Table 1 and text for details.

C. Project Description

1. Resource

The impacted resource is the declining population of pigeon guillemots in PWS.

2. Objectives

Identify and map pigeon guillemot colonies within the trajectory of the spill within Prince William Sound.

3. Methods

a. Study Area

This study will focus mainly on shorelines within the trajectory of the spill within PWS (Figure 2). For survey purposes, we divided the Sound into eleven sub-areas and prioritized each according to three degrees of oiling (Table 1). We will survey the sub-areas in sequence, by three levels of priority. Priority 1 areas are those that were heavily oiled, and priority 2 areas were oiled lightly or they contain other potentially-harmful environmental threats such as clear-cut logging (Port Fidalgo area) that could possibly influence overall guillemot population restoration. Priority 3 areas were unoiled.

b. Data Collection

We will collect data during the critical early stage of the breeding season (Thoreson and Booth 1958, Drent 1965, Kuletz 1983). Guillemots display and socialize by roosting on rocks and on the water at their nesting colonies in May and June, before eggs start hatching and parents are occupied with feeding chicks (Drent *loc. cit.*, Kuletz *loc. cit.*). Characteristic behavior such as roosting on rocks, flying back and forth between the water and shore, and reluctance to leave the vicinity indicate the presence of a nesting colony (Drent *loc. cit.*). This behavior is most prevalent in the morning (0500 - 1000 h), especially during high tide, and again within two hours of high tide at other times of the day (Kuletz unpublished data, Cody and Gehrlach 1993, Drent *loc. cit.*, Nettleship 1976). The lowest counts at Naked Island, including the absence of birds outside of their crevice-nests, were when low tide occurred in the afternoon (Kuletz, unpublished data).

Thus, most surveys will be done in the early morning. When guillemots are sighted, their location, numbers, behavior, the date, time of day, and tide height will be recorded, and marked on standard U. S. Geological Survey topographic maps. Colonies will be further delineated by extent of shoreline that is occupied by guillemots, and by concentrations within the colony.

Table 1. Criteria for planning guillemot colony surveys in Prince William Sound, using three boats and assuming a survey rate of 30 km/da/boat. Shoreline lengths from Irons et. al. (1988).

Area Name	Census Priority	Shoreline Length Km.	Survey Days
Oiled Areas			
Knight-Montague (Knight, Green, Montague Isls)	1	646.0	7.2
Southwestern (Icy Bay to Port Bainbridge)	1	522.0	5.8
Naked-Smith (Naked I. Archipelago, Smith Isls)	1	112.5	1.3
West-central (South) (Port Nellie Juan to Dangerous Passage and Chenega I)	1	468.0	5.2
West-central (North) (Passage Canal to , Blackstone & Cochrane Bays, Culross Passage & Island, & Perry I.)	2	394.5	4.4
		Subtotal 2,143	24
Unoiled Areas			
Port Fidalgo	2	261.4	2.9
Port Gravina	3	257.1	2.9
Northwestern (Port Wells, College-Harriman Fjords)	3	239.1	2.7
North-central (S Esther I to Columbia Bay/Pt.Freemantle)	3	532.3	5.9
Northeastern (Valdez Arm, Port Valdez)	3	261.4	4.4
Southeastern (Hinchinbrook I, Hawkins I, to Cordova)	3	426.3	4.7
		Subtotal 1,978	24
		TOTAL 4,121	48

Depending on individual circumstances, colony descriptions may include any or all of the following: Latitude/longitude or other descriptors of boundaries; distribution of birds within the colony (i.e., evenly-spaced or clumped); distinctive landmarks; and photographs and sketches of nesting and roosting areas. Because guillemots may nest as isolated pairs or in very low densities, individual nesting pairs will also be noted.

Project personnel will do most of the surveys, using two 14' inflatable skiffs and a 25' Boston Whaler. We will take advantage of the presence of two other FWS field crews to expand our data collection. Greg Golet, who is studying kittiwakes near Valdez for a non-oil spill project, will survey Port Valdez for guillemots, and Brad Andrus, project leader for Restoration Project 93035 (black oystercatchers), will cover parts of the Knight Island and Green Island areas during periods that will not interfere with his work.

Three teams of two observers each from the guillemot project will look for guillemots while traveling at about 6-8 knots about 50 m from the shoreline. Assuming an average survey rate of 30 km of shoreline per boat per day, we estimate that it would take a minimum of 45 days for three crews to survey the entire Sound (Table 1). To assure efficient use of the approximately 40 days available for charter-boat support, we will complete the surveys among several sub-areas according to the three priority levels described above.

Data will be transferred to standard forms in the field. The following information will be included: date; transect length in km; corresponding Bird Study 2 shoreline transect number; colony location; USGS quadrangle map name; appropriate place name(s); latitude and longitude (portable GPS navigation); tidal activity (beginning, ending, and peak heights), locations of colonies within transect; numbers of birds on land and on water at each colony; and, the guillemots' behavior.

Photographs will be taken at selected colonies with a 35 mm camera equipped with a 70-210 mm zoom lens to document colony habitat types, and photographic records of the colonies.

A flyer will be designed and sent to other agencies doing field work in PWS, to harbormasters at Cordova, Valdez, and Whittier for posting on public bulletin boards, and to the Whittier Boat Owner's Association, requesting that boaters be on the lookout for groups of guillemots, and to report their observations to us. This will require minimal effort, and it could add to or corroborate the formal survey.

c. Data Analysis

Data on locations and population estimates of colonies will be tabulated and mapped using the FWS's Alaska Seabird Colony Catalog computer system. A tabular listing of all pigeon guillemot colonies will include location, and number of birds at each, summarized by sampling area (Table 1, Figure 2).

We will compile a frequency histogram of colonies by size for each sampling area, and for PWS as a whole. Tables and graphs will summarize data for each geographic area by total colonies, total birds, average and standard deviation of bird numbers, and average number of colonies and birds per km of shoreline.

4. Alternatives

The survey method that we propose to use is standard protocol for censusing guillemót colonies (Cairns 1979, Evans 1980, Ewins 1985, Cody and Gehrlach 1993), and we know of no viable alternatives.

5. Location

Table 1 and Figure 2 indicate the areas that we will survey. Within priority 1 and 2 areas we will survey all shoreline with potential nesting habitat. In priority 3 areas, if time remains in our charter boat contract, we will survey known colonies, and as much other shorelines with good nesting potential as possible. Shorelines of mud flats, and other habitats with low potential for guillemot colonies will not be surveyed.

6. Benefits

The main benefit of this project will be the establishment of baseline data on the locations and sizes of pigeon guillemot colonies in PWS. This information is important for evaluating management actions proposed to help restore the population. This project will also allow an evaluation of the importance of the Naked Island area for the overall guillemot population in the Sound, and it will identify which other colonies may be suitable for future monitoring.

7. Technical Support

The manager of the Alaska Seabird Colony Catalog (Dr. Vivian Mendenhall) will be available for advice regarding computer data entry, and the graphical and tabular products that the system is capable of producing (e.g., Figure 1 of this proposal) . We will also use the FWS Geographic Information System office (Tom Jennings) to create large-scale maps that show shoreline habitats in areas where we find concentrations of guillemot colonies.

8. Contracts

A vessel suitable for sleeping, meals and other logistical support for a field crew of six will be chartered for a period of about 40 days between mid-May and the end of June. The FWS office of Contracting and

General Services is handling the contract, which has been awarded to the low bidder, Choice Marine Charters. Survey boat fuel, personnel safety training, and repairs and maintenance of survey boats and equipment will be contracted.

9. Mitigation Measures

No mitigation measures are required because of the passive nature of this study.

10. Literature Cited

Cody, M., J. Fadely, and T. Gehrlach. 1993. Pigeon guillemot colony locations along the northern and southwestern coast of Afognak Island, Alaska. Unpubl. Rept., U. S. Fish and Wildlife Service, Anchorage, AK.

DeGange, A. R. and G. A. Sanger. 1986. Marine birds, pp. 479-524 (Ch. 16), *In*: D. W. Hood and S. T. Zimmerman (eds.), *The Gulf of Alaska: Physical environment and biological resources.* US Dept. Comm., Min. Mgt. Svc. Publ. No.: MMS 86-0095. 655 pp.

Cairns, D. 1979. Censusing hole-nesting auks by visual counts. *Bird Banding*, 50:358 - 364

Drent, R. 1965. Breeding biology of the pigeon guillemot, *Cepphus columba*. *Ardea* 53:99-160

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Oakley, K. 1981. Determinants of the population size and distribution of the pigeon guillemot (*Cepphus columba*). M. S. Thesis, Univ. Alaska, Fairbanks

Oakley, K. 1990. Assessment of injury to waterbirds from the *Exxon Valdez* oil spill: Effects on the population and reproductive success of pigeon guillemots in Prince William Sound. *Exxon Valdez* oil spill Bird Study No. 9, *1989 Final Report*, U. S. Fish and Wildl. Serv., Anchorage, AK.

Oakley, K. and K. Kuletz. ms. Effects of the *Exxon Valdez* oil spill on pigeon guillemots breeding at Naked Island, Prince William Sound, Alaska. *Exxon Valdez* oil spill Bird Study No. 9, *Final Report*, US Fish and Wildl. Serv., Anchorage, AK

Piatt, J., C. J. Lensink, W. Butler, M. Kendziorek, and D. R. Nysewander. 1990. Immediate impact of the *Exxon Valdez* oil spill on marine birds. *Auk*, 107:387-397.

Sanger, G. A. 1983. Diets and food web relationships of seabirds in the Gulf of Alaska and adjacent marine regions. US. Dept. Commerce, OCSEAP Final Rep 45 (1986): 631-771.

Sowls, A., S. A. Hatch, and C. J. Lensink. 1978. Catalog of Alaskan seabird colonies. U. S. Dept. Int., Fish Wildl. Svc, Office Biol. Svc., FWS/OBS-78-78

Thoresen, A. C. and E. S. Booth. 1958. Breeding activities of the pigeon guillemot, *Cepphus columba columba* (Pallas). *Publ. Biol. Sta. Walla Walla Coll.*, No 23:1-37.

D. Schedules and Planning

1. Milestones (1993)

Jan 19:	Project approval from Trustees' Office.
Feb 8:	Hire Project Leader (temporary joint assignment to Boat Survey Project, February 8 - March 19)
Feb - Apr:	Prepare proposal, plan logistics, hire personnel
Apr 19:	Biotechs begin work (shared appointment with murrelet project, using separate cost codes)
Apr 19 - May 7:	Biotech training - Safety, survival, field techniques
May 10 - 16:	Field techniques training, based from Whittier
May 17 - June 30:	Conduct colony surveys
July - Sep:	Analyze data, write report

Oct 1: Draft report to Oil Spill Office

Nov 15: Submit final report to Chief Scientist for peer review

2. Project Personnel

Job Title	Grade Level	Months FY 93	Months FY 94	Responsibilities
Project Manager	GS-13	Mar-Sep	Oct - Nov	Oversee project, forward information from Trustees to Project Leader, ensure that latter meets deadlines. Expedite project needs when crew is in field.
Project Leader	GS-11	Mar-Sep	Oct - Nov	Supervise project design, data collection, data analysis, Colony Catalog data entry, prepare draft and final reports. Boat operator.
Associate Investigator	GS -6	Mar - Aug		Supervise field training, assist with field study design, hiring, logistics, data collection and analysis, and draft report. Boat operator.
Biological Technician (1)	GS - 5	Apr - Jun		Boat operator, data collection, equipment maintenance.
Biological Technician (3)	GS - 5	Apr - Jun		Data collection, equipment maintenance.

3. Logistics

Surveys will require the use of two 14' inflatable skiffs and a 25' cruiser, which are the property of the U. S. Fish and Wildlife Service. In addition, a vessel will be chartered for lodging, meals and logistics support of the survey boats. The vessel charter will originate and end at Whittier, and it is anticipated that the charter boat will return to Whittier or other Prince William Sound Port approximately every two weeks for a work break and to re-provision survey boat fuel and other supplies.

E. Environmental Compliance/Permits/Coordination

This study relies on observations from boats and is a non-intrusive study. Based on a review of CEQ regulation 40 CFR 1500-1508, this study has been determined to be categorically exempt from the requirements of NEPA, in accordance with 40 CFR 1508.4.

F. Performance Monitoring

1. Chain of Command and Back-up Strategy

   U. S. Fish and Wildlife Service - Region 7
   Chief of Migratory Bird Management - Robert Leedy
   Project Leader, Marine and Coastal Bird Project - Kenton D. Wohl
   Project Leader, Pigeon Guillemot Colony Survey - Gerald A. Sanger

   If personnel changes occur, replacements will be hired and trained accordingly. Despite personnel changes and other logistical obstacles, MBM has successfully conducted work similar to this survey for several years, and it is therefore unlikely that project time frames will not be met.

2. Quality-assurance and Control Plan

   To ensure consistently high-quality data collection, data analyses and report preparation, these procedures will be followed: (1) Under the guidance of Mary Cody, project personnel will participate in an office orientation and practice field surveys before actual surveys take place; (2) One person on each boat will be responsible for maintaining consistent field procedures, and all data will be field checked daily; 3) Data will be recorded on topographic maps in a consistent manner, and all data will be summarized on standard data forms (Appendix 1); (4) Locations of colonies will be described and cross-referenced in four ways:

   a. By marking locations directly on topographic maps in the field;

   b. By photographing and/or sketching the layout of the colony as it appears from 50 m away on the water, indicating distinctive landmarks such as, e.g., large boulders, crooked trees, cracks in rock faces;

   c. By recording latitude-longitude coordinates as measured by a portable GPS unit; and,

   d. By refining and pinpointing colony locations in the office by cross-referencing field data with high-resolution aerial photographs of Prince William Sound on file with the U. S. Forest Service.

   (5) Field data will be double checked in the field by a second person; (6) Data entered into the Alaska Seabird Colony Catalog will follow standard fish and Wildlife Service protocols.

3. Final Products

   a. Final report

b. Incorporation of data on colony location and status for Prince William Sound pigeon guillemot colonies into the Alaska Seabird Colony Catalog

G. Personnel Qualifications

1. Project Manager - Kenton D. Wohl

Mr. Wohl has been involved in the monitoring and management of Alaskan marine and coastal birds for over 20 years. He has recently collaborated with Russian colleagues on the conservation and management of Beringian seabirds. As Nongame Coordinator for FWS Region 7, Mr. Wohl oversees a staff of five full-time biologists who work with seabirds, shorebirds and other non-game wildlife species. During the summer field season, he supervises an additional temporary staff of 20. Mr. Wohl has spent his entire career in Alaska, and he is familiar with the logistical requirements necessary to make a field project work.

1. Project Leader - Gerald A. Sanger

Mr. Sanger received a B. S. in Fisheries Biology from Humboldt State University in 1959, and completed an additional 32 hours of course work in oceanography and biology at the University of Washington. Mr. Sanger has had a long and productive career in oceanography and marine wildlife biology that included tours with the National Marine Fisheries Service and the National Marine Mammal Laboratory in Seattle for eight years. For 12 years he was a Principal Investigator in seabird studies with the Alaska Outer Continental Shelf Environmental Assessment Program and the Alaska Fish and Wildlife Research Center of the FWS. He has published 32 technical papers, mostly on seabirds. In 1987, Mr. Sanger started a sightseeing and transportation charter boat business that operated out of Whittier for five summers, and he holds a U. S. Coast Guard Master's License (50-ton, Inland). In the off season he has occasionally been employed by the FWS as a Wildlife Biologist. Mr. Sanger's other involvement with PWS included a year-long tour with the U. S. Forest Service as a Wildlife Biologist/Planner preceding his return to the Fish and Wildlife Service in February 1993, assisting Whittier's Oil Spill Response Office with a beach survey project, and a year's service as a member of the Scientific Advisory Committee of the Regional Citizen's Advisory Council.

Selected relevant publications:

Hatch, S., and G. A. Sanger. 1992. Puffins as samplers of juvenile pollock and other forage fish in the Gulf of Alaska," *Mar. Ecol. Prog. Ser.*, 80:1-14.

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King, J. G., and G. A. Sanger. 1979. Oil vulnerability index for marine oriented birds, pp. 227-240, In: *Conservation of marine birds of northern North America*. US Dept. Int., Fish and Wildl. Ser., *Wildl. Res. Rept.* 11.

3. Associate Investigator - Mary Cody

Ms. Cody received a B. A. from the University of Michigan in 1985, and completed 26 hours of course work in wildlife biology at Oregon State University and the University of Alaska in 1991-92. She has had four consecutive years of field experience with oil spill seabird studies. She worked on the PWS Bird Study 12 (black oystercatchers) in 1989, the FWS marbled murrelet and pigeon guillemot studies from 1990 to 1992, and was acting Field Project Leader for part of the 1990 season. In 1992, she was field crew leader for guillemot and murrelet studies on Afognak Island, Alaska, that were mandated by Congress. In this position she trained personnel, and designed and supervised surveys.

Selected relevant publications and reports:

Naslund, N. L., K. J. Kuletz, M. B. Cody and D. K. Marks. In press. Tree and habitat characteristics and behavior at fourteen marbled murrelet tree nests in Alaska, In: *Proceed. 1993 Marbled Murrelet Symp*, Pac. Seabird Group

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Cody, M., J. Fadely and T. Gehrlach. 1993. Population indices of nesting seabirds along the northern and southern coast of

Afognak Island, Alaska. Unpubl. Rept., U. S. Fish and Wildlife Service, Anchorage, AK

Cody, M., J. Fadely and T. Gehrlach. 1993. Pigeon guillemot colony locations along the northern and southwestern coast of Afognak Island, Alaska. Unpubl. Rept., U. S. Fish and Wildlife Service, Anchorage, AK

Andres, B. and M. B. Cody. 1993. The effects of the *Exxon Valdez* oil spill on black oystercatchers breeding in Prince William Sound. Unpubl. Rept., U. S. Fish and Wildlife Service, Anchorage, AK

H. Budget

The project budget is outlined on the following two pages. The total FY 93 cost of the project is the same as that presented in the draft budget for the 1993 work plan. However, we have allocated project costs somewhat differently. Personnel costs are higher, and costs in other budget categories are lower. Higher personnel costs are due primarily to a higher salary than originally planned for the Project Leader, who draws a salary commensurate with his status as a senior biologist.

Project Description: Pigeon Guillemot Colony Survey. This project will locate and map pigeon guillemot colonies in the spill affected area. The data will be incorporated into a catalog of Alaskan Seabird Colonies and used by the Trustee Council in restoration efforts.

Budget Category	Approved 01-Oct-92 28-Feb-93	Proposed* 01-Mar-93 30-Sep-93	Total FY 93	FY 94	FY 95	FY 96	FY 97	Sum FY 98 & Beyond
Personnel		88.0	88.0	9.7				
Travel		4.4	4.4	0.0				
Contractural		49.5	49.5	0.0				
Commodities		6.2	6.2	0.0				
Equipment		1.0	1.0	0.0				
Capital Outlay		0.0	0.0	0.0				
Sub Total	0.0	149.1	149.1	9.7	0.0	0.0	0.0	0.0
General Administration		16.7	16.7	1.5				
Project Total	0.0	165.8	165.8	11.2	0.0	0.0	0.0	0.0
Full-time Equivalents (FTE)		2.5	2.5	0.2				

Amounts are shown in thousands of dollars.

Budget Year Proposed Personnel:

	Position	Months Budgeted	Cost
FY 93	Principal Investigator, GS-11 Biologist	7.0	36,000
	Supervisory Biologist	0.5	3,000
	Biologist, GS-6 (incl. o.t.)	5.5	15,000
	Program Manager	1.0	5,000
	Expeditor	1.0	2,000
	Biological Tech, GS-5 (4 @ 2.5 mos, incl. o.t.)	10.0	27,000
FY 94	Principal Investigator, GS-11 Biologist	2.5	9,700

* FY 93 is a transition year from the previously-used oil fiscal year to the federal fiscal year. This new project also includes proposed funding for January and February, 1993.

Project Number: 93034
Project Title: Pigeon Guillemot Colony Survey
Agency: US Fish & Wildlife Service

FORM 2A
PROJECT
DETAIL

			Proposed
Travel:	Includes travel to Prince William Sound by train, boat, or air, and per diem.		$4.4
Contractural:	GIS support		$2.0
	Training		$1.5
	Boat repair		$4.0
	40-day vessel contract		$40.0
	Equipment warehouse rental (part)		$2.0
		Sub-total	$49.5
Commodities:	Food		$0.5
	Fuel		$5.0
	Camp supplies		$0.7
		Sub-total	$6.2
	Boat equipment (anchors, line, spare gas tanks, misc.)		$1.0
		Sub-total	$1.0

93035

DRAFT EXXON VALDEZ DETAILED PROJECT DESCRIPTION

Project Title: Potential Impacts of Oiled Mussel Beds on Higher Organisms: Contamination of Black Oystercatchers Breeding on Persistently Oiled Sites in Prince William Sound

Project ID#: 93035

Project Type: Restoration Monitoring/Restoration Manipulation

Project Leader: Brad A. Andres

Lead Agency: U. S. Department of the Interior, Fish and Wildlife Service

Cooperating Agencies: National Oceanic and Atmospheric Administration, Alaska Department of Fish and Game

Project Cost: FY 93 - $121.7; FY 94 - $17.3

Start Date: January 1, 1993 **Finish Date:** March 15, 1994

Project Location: Fieldwork will be conducted in Prince William Sound, mussel hydrocarbon analysis at Auke Bay Laboratory, Juneau, hydrocarbon analysis of oystercatcher feces at Texas A&M University and data analysis and report writing in Anchorage.

Project Leader: Brad A. Andres Brad A. Andres **Date:** 4/7/93

Project Manager: Kenton D. Wohl Kenton D. Wohl **Date:** 4/7/93

B. Introduction

The persistence of high concentrations of petroleum hydrocarbons spilled by the *Exxon Valdez* in the mussel beds (*Mytilus trossulus*) of Prince William Sound has raised questions regarding the chronic exposure of intertidal consumers to oil. The obligate use of intertidal foraging areas by black oystercatchers (*Haematopus bachmani*) make them highly susceptible to chronic, shoreline oiling problems. As part of the oiled mussel bed project (Restoration Project Number 103, see 1992 Draft Work Plan), work in 1992 focused on documenting the potential for exposure of black oystercatchers to oil persisting in the environment. The loss of funds for conducting hydrocarbon analysis of fecal samples of oystercatcher chicks delayed the direct determination of exposure in 1992. This study will directly document the exposure of black oystercatchers to oil remaining in the mussel beds, and fine sediments, of Prince William Sound through hydrocarbon analysis of the feces of black oystercatcher chicks. This study will also determine the survival of chicks raised in and recruitment of breeders into persistently oiled areas of Prince William Sound.

Hydrocarbon concentrations in some mussel beds in Prince William Sound remained relatively unchanged between 1991 and 1992 (P. Rounds, NOAA, pers. commun.). Mussel and sediment samples were collected by NOAA, ADF&G and USFWS personnel at 49 contaminated sites in 1992. Sediment samples, screened by UV fluorescence, from 19 mussel beds had concentrations >10,000 μg/g wet weight oil equivalents (P. Rounds, NOAA, pers. commun.); 10 samples from oystercatcher feeding sites had detectable concentrations of petroleum hydrocarbons. In addition to samples obtained from dense mussels beds, where the byssal mat was found to retain oil (M. Babcock, NOAA, pers. commun.), samples from oystercatcher feeding sites were collected from substrates that supported only moderately dense aggregations of mussels (Andres 1993). Although hydrocarbon concentrations were lower in these beds than in dense mussel beds, doses of weathered crude oil as small as 2 ml have negatively affected reproduction in birds (Fry et al. 1986). Thus, the potential for exposure of oystercatchers to persistent oil extends beyond dense, oiled mussel beds.

The potential for exposure of black oystercatchers to oil was further assessed by observing their foraging behavior. Black oystercatchers did not avoid feeding in or delivering prey to chicks from persistently oiled substrates (Andres 1993). However, where territories included oiled and unoiled feeding sites, adults spent less time foraging in oiled patches than in unoiled patches. Rate and amount of food consumed by adult oystercatchers foraging on oiled substrates was greater than birds feeding on unoiled substrates. Adults and chicks clearly had the potential for being exposed to petroleum hydrocarbons persisting in oiled substrates in 1992.

Indirect evidence of injury to black oystercatchers resulting from chronic oil exposure was obtained. Despite being fed more biomass, chicks raised at persistently oiled nest sites grew slower than chicks at unoiled nest sites (Andres 1993). These results corroborated findings of 1991 (Andres 1992). Females renesting at oiled sites produced fewer eggs of lesser volume than females renesting at unoiled sites. The

consistency of results, between years and among measurements, is highly suggestive of oil ingestion (Miller et al. 1978). To verify exposure to oil, fecal samples of oystercatcher chicks were collected and are currently undergoing analysis for hydrocarbon contamination (through funding provided by USFWS). A rough index of contamination, based on the clarity of fecal-dichloromethane solutions (Fry ND) indicated that chicks inhabiting persistently oiled nest sites were ingesting oil (Andres 1993).

The discovery of numerous oiled sites in 1992 indicates that the problem of oil persisting in mussel beds, and other fine sediments, is more widespread than initially thought. The occurrence of detectable amounts of hydrocarbons in the fine sediments underlying moderately dense or sparse mussel beds, as well as in dense mussel beds, indicates that breeding oystercatchers are subject to broad risks of chronic oil exposure. Nothing is known about how reduced chick growth rates translate to overwinter survival of chicks and, eventually, recruitment into the breeding population. The summer of 1993 represents the first year that oystercatchers fledged in the oil spill year of 1989 have the potential to enter the breeding population. Continued individual and population monitoring is needed to evaluate the magnitude and duration of chronic effects of the *Exxon Valdez* oil spill on black oystercatchers inhabiting Prince William Sound.

C. Project Description

This study will document the exposure of black oystercatchers to oil persisting in the mussel beds and fine sediments of Prince William Sound. Recruitment into the Sound's oystercatcher population breeding within the spill zone will be monitored.

1. Resource

   The resources to be studied are black oystercatchers inhabiting territories that include oiled mussel beds, and possibly, other contaminated prey, and those inhabiting unoiled territories within Prince William Sound.

2. Objectives

   a. To determine if the continued persistence of hydrocarbons in mussel beds is being transferred to oystercatcher chicks via the food chain and is responsible for depressed growth rates.

   b. To assess the recruitment of oystercatchers into the breeding population and the survival of sub-adult birds that were raised in oiled territories.

3. Methods

Exposure of black oystercatchers to oil will be documented by observing where birds forage and what they eat and by analyzing the feces of chicks for hydrocarbon contamination. Continuing injury to black oystercatchers will be determined by comparing growth rate of chicks, survival of sub-adults and recruitment of breeders at persistently oiled and unoiled sites.

a. Exposure of oystercatchers to oil

i. Study area

Work in 1993 will focus on oystercatcher territories in the vicinity of Knight Island, Prince William Sound, where contaminated sediments underlying mussels were identified in 1992 (P. Rounds, NOAA, pers. commun.) . Nine oystercatcher territories were studied in 1992 and will be resampled in 1993. Additional "hot" sites identified in Foul Bay and on the north end of Chenega Island will be surveyed for the presence of breeding oystercatchers. As results from 1992 mussel samples, 1992 oystercatcher fecal samples and 1993 identification of oiled mussel beds become available, additional sites might be included. Nests at oiled sites that did not hatch chicks in 1992 will also be targeted for study. Oystercatcher territories occurring in unoiled areas of Knight Island will be selected for comparative study.

ii. Data collection

Beginning in mid-May, oystercatcher nests (>90 in 1992) will be located and their progress will be followed. Weights, tarsus length and bill length will be measured on chicks ≥7 days of age, Each chick will be fitted with a unique color-band combination. Chicks will be reweighed and remeasured at 7 to 10 day intervals.

Observations of feeding adults will be made to document specific areas of potential exposure. All feeding sites will be thoroughly searched for the presence of oil. A list of beach segments containing visible or olfactory signs of oil will be compiled and transmitted to NOAA for inclusion as oiled mussel bed sampling sites.

Attempts to collect fecal samples of chicks will be made at 7 to 10 day intervals once chicks are 1 week old. Chicks will be placed in a cleansed teflon pan, for a maximum of 10 minutes, to collect feces. Feces will be transferred, by a sterilized, disposal pipette, to a sterilized jar containing 10 ml of dichloromethane.

Combining multiple temporal samples collected from all chicks present at the nest site during a sampling period will maximize the chance of detecting hydrocarbons in the feces of oystercatcher chicks. One pooled sample from each nest site will be submitted for hydrocarbon analysis. Samples from ≥10 persistently oiled sites and ≥5 unoiled sites will be collected. Blanks will be made for every 10 samples collected.

iii. Data analysis

An index of growth (instantaneous change in weight/instantaneous change in tarsus length) will be contrasted, by a t-test of the means, between chicks raised at chronically oiled and those raised at unoiled sites.

Fecal samples will be sent to the Geochemical and Environmental Research Group of the Texas A&M University for gas chromatography-mass spectroscopy determination of aliphatic hydrocarbon (AH) and polycyclic aromatic hydrocarbon (PAH) concentrations. Details of the analytical methods are in GERG standard operating procedures, SOP-8901 to SOP-8905. The tissue extraction method was initially developed by Macleod et al. (1985) and later modified by Wade et al. (1988). Hydrocarbon concentrations in feces will be compared to sediment and mussel concentrations (collected by NOAA) at nest sites. Indices of oil contamination (Manen 1990) of feces of chicks raised in territories that include oiled substrates will be contrasted with those raised in unoiled territories.

b. Recruitment and survival of sub-adult oystercatchers

i. Study area

Recruitment will be monitored in the vicinity of Knight, Green and Montague islands. Chicks banded in previous years (1991 and 1992) will be searched for in non-breeding flocks that congregate in Gibbon Anchorage on Green Island and in Port Chalmers on Montague Island (Andres, pers. obs.),

ii. Data collection

The number of breeding pairs occurring on Green and Montague islands, where work has been conducted since 1989, and on Knight Island will be counted to monitor population changes and recruitment into the breeding population. Counts of breeding pairs

will be made during routine data collection of fecal samples and growth rates of chicks.

Four trips will be made to Green and Montague islands to search for previously banded sub-adult oystercatchers. All observations of color-banded birds observed during routine data collection will also be recorded.

iii. Data analysis

Numbers of breeding pairs inhabiting oiled and unoiled areas of the study area in 1993 will be graphically compared to those present in past years. Changes in the number of breeding pairs will be contrasted between oiled and unoiled sites. Chick survival will be calculated as the proportion (of the total number fledged) of chicks alive 1 and 2 years after fledging. Survival of chicks raised at persistently oiled sites will be contrasted to that of chicks raised at unoiled sites.

4. Alternatives

Analyses of regurgitated prey items and blood samples have been considered as alternatives to collecting fecal samples. In both instances, these techniques were deemed inappropriate for small chicks that might already be stressed. Because hydrocarbons are identifiable in the feces of birds (Fry, ND), the ease of collecting the material makes fecal sample analysis the most viable technique for establishing the link between oiled mussel beds and oil in the tissue of oystercatchers.

5. Location

Primary study sites will include Green, Knight and Montague Islands, Prince William Sound, Alaska (Fig. 1).

6. Benefits

This study will be beneficial to the restoration of black oystercatchers because the study will determine whether continuing injury or recovery is occurring at oiled sites. If recovery is not occurring, the study is designed to reveal whether a cause of the continuing injury to oystercatchers is the use of oiled mussel beds for feeding. This study will identify specific mussel beds, or other oiled substrates, and their characteristics that result in the continuing injury to oystercatchers. These data could be used to identify sites needing additional treatment. Treatment of such sites will eventually benefit oystercatchers by returning their foraging areas to a normal condition.

7. Technical Support

Hydrocarbon analysis and interpretation of results from fecal samples will be performed by Texas A&M University. Hydrocarbon analysis and interpretation of results from mussel and sediment samples will be conducted by the NOAA's Auke Bay Laboratory.

8. Contracts

Food, lodging, freezer storage and laboratory space at the study site will be awarded as a sole-source contract. Justification for this contract is provided in Appendix A.

Analysis of *Exxon Valdez* tissue samples collected by USFWS for the presence of petroleum hydrocarbons, including analysis by gas chromatography-mass spectroscopy of oystercatcher feces, was awarded to the Geochemical and Environmental Research Group of the Texas A&M University through a competitive, multi-year contract. The complexity of analytical procedures to determine hydrocarbon contamination and the specialized equipment needed to conduct analyses necessitate an outside contract.

Vessel maintenance and repair that requires expertise and equipment beyond what is available at the Regional Office of the USFWS is awarded to local Anchorage businesses through competitive, multi-year bids. Work on vessels used in this project is performed by Magnum Marine and Sea Marita Boatworks.

Warehouse space, for the storage of vessels and equipment, was awarded to an Anchorage facility through an open, multi-year competitive bid.

9. Mitigation

No mitigation is required because this project qualifies for a NEPA exemption.

10. Literature Cited

Andres, B. A. 1993. Potential impacts of oiled mussel beds on higher organisms: Black oystercatchers. Unpubl. Rept., *Exxon Valdez* Oil Spill Public Information Office, Anchorage, Alas.

Andres, B. A. 1992. Feeding ecology and reproductive success of black oystercatchers in Prince William Sound -- draft. Restoration Study Number 17, pp. 30448608 - 30448638 *in Exxon Valdez* Oil Spill Restoration Planning Documents, Oil Spill Public Information Center, Anchorage, Alas.

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Manen, C. 1990. Hydrocarbon analytical support services and analysis of distribution and weathering of spilled oil -- draft. Technical Services Number 1, pp. 30448996-30448996 *in Exxon Valdez* Oil Spill Natural Resource Damage Assessment Documents, Oil Spill Public Information Center, Anchorage, Alas.

Miller, D. S., D. B. Peakall and W. B. Kinter. 1978. Ingestion of crude oil: Sublethal effects in herring gull chicks. Science 199:315-317.

National Research Council. 1985. Oil in the sea: Inputs, fates, and effects. Natl. Acad. Press, Washington, D.C. 601pp.

Wade, T. L., E. L. Atlas, J. M. Brooks, M. C. Kennicutt II, R. G. Fox, J. Sericano, B. Garcia and D. DeFreitas. 1988. NOAA Gulf of Mexico Status and Trends Program: Trace organic contaminant distribution in sediments and oysters. Estuaries 11:171-179.

D. Schedules and Planning

1. Milestones

1993		
	Mar 1 - May 19	Logistical planning and safety training
	May 20 - Aug 10	Field data collection
	Aug 11 - Oct 31	Data entry, data analysis and fecal sample analysis
	Nov 1 - Dec 31	Draft 1993 report writing and internal review
1994		
	Jan 1	Draft report submitted for peer review
	Mar 1	Peer review comments returned to USFWS
	Apr 1	Final report submitted for peer review

2. Project Personnel

Project Manager, Kenton Wohl - oversees the project and forwards information from the Trustees is to the project leader and ensures that project deadlines are met by the project leader. Responsible for expediting project needs while the crew is in the field.

Project Leader, Brad Andres - responsible for collecting, assembling, analyzing and interpreting all data associated with this project. Also responsible for purchasing equipment, initiating contracts and organizing safety training for crew.

Project Bio-technicians - assist with data collection in the field, data entry and equipment maintenance.

3. Logistical Needs

1 boat (25') for long distance transportation between locations in the study area.
1 inflatable skiff (14') for transportation while locating nests and collecting chick fecal samples.
2 motors (30 hp) for the 14' skiff.
Survival equipment for 25' and 14' boats.
Food and lodging for a crew of 2-3 for the duration of the study.
Purchase and delivery of 1000 gallons of fuel.
Foul weather gear for crew.
Freezer storage for fecal samples and laboratory space.

E. Environmental Compliance/Permit/Coordination Status

This study is a non-intrusive study primarily involving observations and infrequent handling of live birds. No birds will be collected. Samples of oystercatcher fecal material and food items will be collected for analysis of hydrocarbon content. Based on a review of CEQ regulation 40 CFR 1500-1508, this study qualifies for a categorical exemption from the requirements of the National Environmental Policy Act, in accordance with 40 CFR 1508.4. The project leader has permission from the USFWS Bird Banding Laboratory to color band oystercatchers and has filed an Animal Use Protocol with the Ohio State University.

F. Performance Monitoring

1. Chain of Command and Back-up Strategy

U. S. Fish and Wildlife Service - Region 7

Office of the Oil Spill - Carol Gorbics and Karen Oakley
Chief of Migratory Bird Management - Robert Leedy

Project Manager - Kenton Wohl
Project Leader - Brad Andres

Although the project leader intends to remain with the project for its one year duration, several biologists from the staff of the Office of Migratory Birds could oversee the project's completion. The project leader is responsible for data collection, field operation and all analytical and interpretive aspects of the project. The Project Manager and branch chief are responsible for transmitting policy decisions of the Trustees to the project leader and ensuring project deadlines are met. The Office of the Oil Spill serves as a liaison between the Project Leader and Manager and the Chief Scientist, Restoration Team and Trustees. The office also reviews reports produced by the project leader.

2. Quality Assurance and Control Plan

Quality control will be accomplished by thoroughly training bio-technicians. Additionally, a bio-technician familiar with the procedures from last year will be rehired. All fecal, mussel and sediment samples will be collected and handled following Standard Operating Procedures previously outlined in Coastal Habitat Damage Assessment studies. Hydrocarbon analyses of fecal and mussel samples follow accepted Standard Operating Procedures. Data collected in the field will be computerized and records will be verified against field forms.

3. List of Products

A report that summarizes the 1993 data and compares it to previously collected data will be completed.

G. Personnel Qualifications

1. Project Leader - Brad A. Andres

Brad received his B. Sc. in Biology from the Pennsylvania State University in 1982 and a M. Sc. in zoology from the Ohio State University in 1989. He is currently working on his Ph. D. in zoology at Ohio State. Brad has spent 175 days of the last two summers studying black oystercatchers in Prince William Sound. Information gathered in these studies will be used for his Ph.D. dissertation. Brad spent three summers studying the habitat use and foraging behavior of post-breeding shorebirds in arctic Alaska. Besides these main endeavors, he has been involved with the analysis of breeding bird population trends. His work in Ohio will culminate (this year) in an 125+ page publication on the status and distribution of Ohio breeding birds derived from national Breeding Bird Survey data. He has presented numerous papers at national and regional meetings and is currently coauthoring the black oystercatcher account for the Birds of North America series.

Relevant Publications:

Andres, B. A. 1993. Coastal zone use by post-breeding shorebirds in arctic Alaska. J. Wildl. Manage. in press.

2. Project Manager - Kenton D. Wohl

Kent has been involved in the monitoring and management of marine and coastal birds for more than 20 years. He has recently been involved in collaborations with Russian colleagues on the conservation and management of Beringian seabirds. As Nongame Coordinator for Region 7, Kent oversees a staff of 5 full-time biologists who work with seabirds, shorebirds and other nongame species. During the summer field season, he supervises an additional temporary staff of 20 individuals. Kent has spent his entire career in Alaska and is familiar with the logistical requirements needed to make a field project successful.

H. Budget

The budget for project 93035 is attached. Deviations from previous budget details resulted from an incorrect determination of agency overhead. FY 94 costs are for the Project Leader to analyze data and prepare the report.

Project Description: Potential impacts of oiled mussel beds on higher organisms: Contamination of black oystercatchers breeding on persistently oiled sites

Budget Category	Approved 1-Oct-92 28-Feb-93	Proposed* 1-Mar-93 30-Sep-93	Total FY 93	FY 94*	FY95	FY 96	FY 97	Sum FY 98 & Beyond
Personnel	$12.0	$38.0	$50.0	$15.0				
Travel	0.0	4.0	4.0	0.0				
Contractual	0.0	48.0	48.0	0.0				
Commodities	0.0	6.0	6.0	0.0				
Equipment	0.0	3.0	3.0	0.0				
Capital Outlay	0.0	0.0	0.0	0.0				
Sub-total	$12.0	$99.0	$111.0	$15.0	0.0	0.0	0.0	0.0
General Administration	1.8	8.9	10.7	2.3				
Project Total	$13.8	$107.9	$121.7	$17.3	0.0	0.0	0.0	0.0
Full-time Equivalents (FTE)	0.3	1.1	1.4	0.3				

Amounts shown in thousands of dollars

Budget Year Proposed Personnel: 1 Mar 93 to 30 Sep 93

Position	Months Budgeted	Cost	Comments
Project Leader	4.0	$13.0	
Project Manager	0.5	3.0	
Program Manager	1.0	6.0	
Project Biotechnicians (2)	3.5	15.0	
Expeditor	0.5	1.0	

*FY 93 is a transition year from previously used oil spill fiscal year to the federal fiscal year. This project includes proposed funding for January and February, 1993 as well as FY 94 closeout costs that include data analysis and report writing

Project Number: 93035

Project Title: Black Oystercatchers/Oiled Mussel Beds

Agency: Dept. of Interior, Fish & Wildlife Service

FORM 2A PROJECT DETAIL

1993

			Proposed
Travel:	Includes travel to/from Prince William Sound via train, plane and boat.		$4.0
Contractual:	Herring Bay field accommodations		$25.0
	Vessel maintenance		5.0
	Hydrocarbon analysis of fecal samples		15.0
	Warehouse space		3.0
		Subtotal	$48.0
Commodities:	Includes food, fuel, chemicals for sample collection and other miscellaneous expendables		$6.0
Equipment:	Includes miscellaneous vessel and scientific equipment		$3.0

1993

Project Number: 93035

Project Title: Black Oystercatchers/Oiled Mussel Beds

Agency: Dept. of Interior, Fish & Wildlife Service

FORM 2B

PROJECT

DETAIL

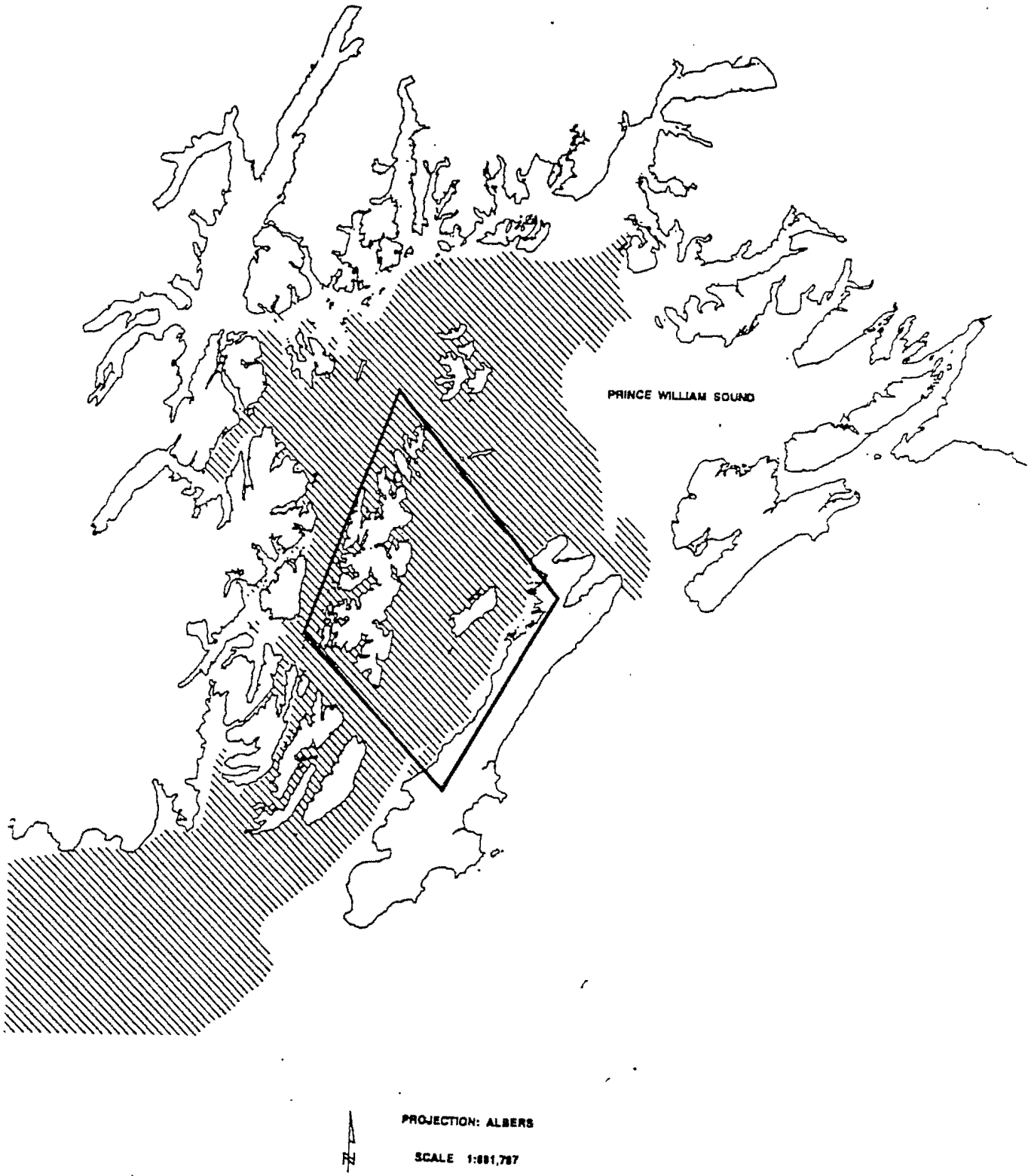

Figure 1. Location of primary black oystercatcher study areas and the oiled zone in Prince William Sound, Alaska.

Appendix A

Justification for Other Than Full and Open Competition

1. The U.S. Fish and Wildlife Service, Region 7, Office of Migratory Bird Management, 1011 East Tudor Road, Anchorage, Alaska, 99503 is proposing a Firm Fixed-Price Contract for the Camp David Barge (Dave Jessen) to provide housing and related services in Herring Bay, Prince William Sound, Alaska to the personnel of the black oystercatcher *Exxon Valdez* Oil Spill Restoration Project 93035.

2. This contract is for lodging, meals and meal preparation on the Camp David Barge (the barge) located in Herring Bay, Prince William Sound, Alaska. In addition to room and board, the barge will provide lab and freezer space that is crucial for the handling and storage of hydrocarbon tissue samples collected during the project. Adequate lab space and a sample storage facility is critical to the project. The barge will also provide fuel for a 25' boat and inflatables (furnished by USFWS) used to transport USFWS personnel among study sites. Mail service, computer facilities, unlimited warm-water showers, bedding, towels and toiletries are also provided by the barge as well as a secure mooring site for the 25' boat. Two to three researchers will be involved in fieldwork for 85 days during the summer of 1993. The estimated cost for the Oil Spill Year is $24,750

3. The authority permitting other than full and open competition for this acquisition is 41 U.S.C. 253 (c) (1), which is cited under FAR 6.302-1. Only one responsible source and no other supply or service will satisfy the agency requirement of adequate lab space, a stable platform and deep freezer space.

4. The purpose of this project is to determine the effects that chronic oiling have on black oystercatchers in Prince William Sound, Alaska. Intensive fieldwork requires that researchers be present at a remote site in Prince William Sound. Because this project is being operated in conjunction with NOAA personnel, most of the fieldwork will focus on Knight Island. The Camp David Barge is the sole provider of housing and meal services in this area. Camp David Barge personnel have worked with researchers in the past and have been very flexible and responsible in their dealing with field biologists. The barge may be used by State of Alaska and University of Alaska researchers in 1993. Because much of Prince William Sound is designated as Wilderness, the U.S. Forest Service has urged researchers to utilize floating facilities such as the Camp David Barge in this area. Among the methods of this restoration project is the collection of blue mussels and black oystercatcher fecal samples for the analysis of hydrocarbons. It is critical that these samples be handled and stored properly. Improper handling could jeopardize the cooperative goals of the project. Additionally, the barge lab is needed to ensure effective cleaning of

sampling implements and avoid contamination of samples. The barge lab will also be used for measurement of weights and sizes of prey eaten by black oystercatchers. The dry environment provided by the barge ensures that technical equipment (computers, balances) will operate properly for the duration of the season. Because of the long duration of the field season and harsh exposure conditions, small comforts such as warm showers, prepared meals and mail service increase morale and help to ensure that the project is successful.

5. Past history has shown that the Camp David Barge is the sole facility at the remote Knight Island site and no other facility operates in the area.

6. All attempts will be made to obtain a fair and reasonable price for the Government. Prices have been negotiable with past contractors.

7. No other vendor is known to provide these services in the immediate vicinity of Knight Island.

93036

DETAILED RESTORATION PROJECT DESCRIPTION

Project Title: Recovery Monitoring and Restoration of Intertidal Oiled Mussel Beds in Prince William Sound and the Gulf of Alaska Impacted by the *Exxon Valdez* Oil Spill.

Project ID#: 93036

Project Type: Coastal Habitat

Project Leader(s): Stanley D. Rice, NOAA
Malin M. Babcock, NOAA
Gail V. Irvine, NPS
Patricia M. Rounds, NOAA
Christine C. Brodersen, NOAA

Lead Agencies: NOAA/National Marine Fisheries Service
DOI/National Park Service

Cooperating Agencies: DOI/U. S. Fish & Wildlife Service, Alaska Department of Fish and Game, Alaska Department of Environmental Conservation

Project Cost: NOAA: $302.8 NPS: $ 102.0 (Total: $404.8)

Start Date: 1 March 1993 **Finish Date:** 31 December 1997

Geographic Area of Project: Prince William Sound
Kenai and Alaska Peninsulas

Project Leader Signature: Stan Rice

Project Manager:

Name: Bruce Wright Bruce Wright

Signature:

A. Introduction

The persistence of *Exxon Valdez* crude oil underlying some dense mussel (*Mytilus trossulus*) beds in Prince William Sound (PWS) began to cause concern in Spring, 1991, among scientists from federal and state agencies. This presence of relatively unweathered crude oil might provide a source of chronic contamination of the overlying mussels thus being a pathway for continued exposure to petroleum hydrocarbons through ingestion by higher consumers. There may be linkage to 2 species of birds - harlequin ducks and black oystercatchers; and possibly other higher consumers. The presence of these contaminated beds is also of concern for human subsistence.

With the encouragement of the Restoration Team and the Trustee Council, staff from several agencies conducted a field survey and sampled mussels and underlying sediments from several sites in June, 1991. Subsequent sampling of mussels and sediments in 1991 was conducted in cooperation with other, planned field trips (Babcock, 1991). This study was formally funded in 1992 and 62 sites within PWS and 13 sites along the Kenai and Alaska Peninsulas (Gulf of Alaska - GOA) were identified as having visible contamination and sampled for mussels and sediments (Babcock et al., 1993). Minimally intrusive site manipulation and intensive sampling of mussels and sediments were conducted at 3 heavily oiled mussel beds in PWS; evaluation of this technique and measuring changes in petroleum hydrocarbon patterns will continue this field season (Rounds et al., 1993).

In 1992, we documented 50 mussel beds in PWS and 9 mussel beds in GOA which show underlying sediment concentrations in excess of 1700 μg/g oil (Babcock et al, 1993). The highest oil concentrations found in animals or sediments in 1991 and 1992 were in mussels and underlying substrates from oiled mussel beds in PWS (Babcock, 1991; Babcock et al, 1993; Rounds et al, 1993). Data from samples taken from identical sites in 1991 and 1992 show little change in hydrocarbon (HC) levels - indicating little effect from natural cleansing processes 3 and 4 growing seasons following the oil spill.

The chief goals of this study in 1993 are to monitor natural recovery in levels of petroleum hydrocarbons in oiled mussel beds throughout the area affected by the *Exxon Valdez* oil spill, and to follow in detail the recovery of a few experimentally manipulated mussel beds. This information is critical in deciding if future clean-up or removal of mussels is appropriate. Oiled mussel beds will pose a significant and controversial management problem. Treatment, in the form of cleaning, will be difficult and hard to justify and removal will be unpalatable to many. Some biologists fear the impacts of removal of large quantities of mussels on the food availability to some species, even if the mussels are oiled. Other biologists fear the impacts of ingested oiled mussels on sensitive life stages and reproductive events dependent on specialized behaviors. In 1992, we removed strips (30 cm wide) from 3 contaminated mussel beds to allow water circulation and access to the substrates below the densely packed mussel layer in order to facilitate the removal of oil and permit biodegradation to occur at faster rates. The stripping study will evaluate the feasibility of this action on the chemical and biological recovery of the mussels.

A third goal of our study is to determine the biological impacts of chronic exposure to *Exxon Valdez* crude oil on mussels; this sampling is integrated with sampling for the primary

function of collecting samples for chemical analyses. Mussels fill too important of an ecological niche and are too important as a food source for the impacts of chronic exposure to crude oil (for 4+ growing seasons) on their biology to remain unknown.

B. Project Description

1. Resources and/or Services:

The resource is the mussel beds themselves, as food source and habitat, which may be a pathway of oil contamination to higher consumers. Some higher consumers are showing continuing reproductive anomalies in the area impacted by the oil spill in Western PWS.

2. Objectives:

a. To monitor natural recovery in levels of petroleum hydrocarbons in oiled mussel beds, including beds identified and sampled in 1991 and 1992 and additional beds identified by other agency field investigators. Mussels, other associated invertebrates and underlying sediments will be sampled (NOAA, NPS).

b. To monitor recovery in levels of petroleum hydrocarbons in experimentally manipulated mussel beds, including 3 sites treated by NOAA and 2 sites by ADEC in 1992, and additional sites if cleaning of mussels beds is initiated by ADEC in 1993 under Project 93038. Feasibility of other, minimally intrusive manipulative techniques may be tested at 3 oiled mussel bed sites within PWS as well (NOAA).

c. To measure the physiological and reproductive injury caused to mussels themselves by living in oiled mussel beds (NOAA).

3. Methods:

a. **Survey Sampling** Natural recovery and/or persistence of oiling will be monitored at many of the sites identified as moderately to heavily contaminated during the field seasons in 1991 and 1992 in PWS and GOA. We expect to accomplish this sampling during vessel and aircraft field trips.

Mussel and sediment sampling at PWS sites will follow the methods used in previous years. A transect line, generally 30 m long and parallel to the water line (as topography allows), will be laid through the middle of a mussel bed. At 8-10 spots along, and within 1 m above and below, the transect line, a small portion of mussels will be overturned. Composite, or pooled, subsamples of sediments (0-2 cm deep) will be collected in triplicate and placed in HC-free jars. Triplicate pooled samples of twenty

to twenty five mussels each will be collected from the overturned portion and placed in HC-free jars. The GOA mussel and sediment samples will be collected by similar methods, except that one triplicate set of samples will be taken directly from the transect line, and 2 additional triplicate sets will be taken, one from a line 1 m above the transect and one from a line 1 m below it.

Mussel bed sampling will be expanded in 1993 to include invertebrates other than mussels that inhabit the oiled beds and may also be common prey items for harlequin ducks, black oystercatchers and other predators, and as such a likely source of food chain contamination. We will sample littorine snails and other invertebrates for HC analysis when sufficient quantities are available.

For selected mussel samples, oil associated with the mussel shell will be extracted and analyzed by UV fluorescence to examine the quantities of oil on the outside of the shell that may be ingested by predators. Oil concentrations will be expressed in relation to shell surface area.

In 1992, some sediments sampled at contaminated sites deeper than the 0-2 cm depth indicated quite different total oil levels. To evaluate this uneven vertical distribution, we plan to sample sediments at selected sites at depths up to 20 cm or greater.

Freezing, chain-of-custody procedures and record keeping will follow Natural Resource Damage Assessment protocol (Manen et al., in prep.).

Sediment samples will be analyzed by ultraviolet fluorescence as adapted from Krahn et al, 1991. This procedure was instituted at ABL in 1992 successfully. Selected sediments and mussels then will be analyzed by gas chromatography/mass spectroscopy (GC/MS) for quantitative measurements of HC analytes (Larsen et al., 1992).

Data will be analyzed using standard statistical methods. It will be displayed on maps using ABL's Geographical Mapping System, and entered into the *Exxon Valdez* Natural Resource Damage Assessment Hydrocarbon Data Base.

b. **Intensive Sampling & Manipulated Mussel Beds** Chemical recovery in the three beds stripped by NOAA in 1992 (EL013A, KN133A, CH010B) will be evaluated by sampling mussels and underlying sediments in a grid pattern similar to that used in 1992. This year we will sample subsites immediately adjacent those previously sampled in 1992. At each .25 m square subsite, 20 mussels, sediment immediately under the byssal mat (0-2 cm depth), and sediment 5-7 cm below the mat will be collected. At the two mussel beds manipulated by ADEC (Bauer et al., 1992), we will sample subsites immediately adjacent those sampled in 1992 for mussel

and sediment hydrocarbons. Additional sediments immediately outside the five manipulated beds will be collected. As in 1992, additional mussels will be collected from bedrock adjacent both manipulated beds and three oiled unmanipulated beds. To help evaluate seasonal changes in hydrocarbon concentrations and natural recovery, subsites in three oiled unmanipulated beds were sampled periodically in 1992; 1993 subsites will be adjacent subsites sampled in 1992. One sampling cruise is planned for late June. Hydrocarbon sample collection, handling, and freezing will follow NRDA protocol (Manen et al., in prep).

To determine stability along edges of strips, the movement of adults onto stripped areas, and the settling of juveniles on the strips, we photographed the strips at stripping, 30 day post stripping and at the end of the season. Individual mussels were tagged along the initial margins of the strips and their positions recorded on the two subsequent sampling trips. In 1993, monitoring of the strip will continue and additional mussels may be tagged along the strip margins.

Mussel densities at each subsite in the manipulated beds will be calculated to examine the relationship between density and degree of sediment contamination and to detect any density changes since 1992.

Sediments will be screened for total oil concentration by UV fluorescence (Krahn et al., 1991) at the Auke Bay Laboratory. Oil concentrations in these samples will be compared with pre and post stripping concentrations in 1992 and with concentrations in untreated oiled beds and in unoiled control beds to evaluate stripping effects. Concentrations in sediments adjacent to the beds will be compared with concentrations within the bed to examine the armoring effect of mussels on underlying oiled sediments. Based on screening results, selected sediments and mussels will be analyzed by GC/MS (Larsen et al.,1992). GC data will enable examination of hydrocarbon concentration changes in mussels and the relationship between mussel and sediment hydrocarbon levels and composition.

Grain size and total organic content of selected sediments will be determined so that the relationship of these parameters to hydrocarbon distribution within a bed can be examined.

c. **Effects on Mussels** Biological impacts on mussels will be determined by measuring condition and reproductive indices; and byssal thread production rates. We collected samples over the growing season in 1992 from several oiled and control sites. Samples were frozen or fixed in 10% buffered formalin. All 1992 samples were collected during field efforts directed towards measuring chemical indices; and all 1993 samples will be collected while field sampling for the first 2 objectives. We will contract for examination of histopathological aspects of mussels -

reproductive indices and general examination for histopathological abnormalities.

Condition and reproductive indices will measure the long term health of a mussel bed. Condition indices of mussels sampled for hydrocarbons will be determined using methods developed for AW3 and CH1B mussels [condition index = (individual dry weight/internal shell volume) x 100]. Reproductive indices can be calculated in 2 ways: (1) histologically as discussed above and (2) using frozen samples, a rough gonadal index can be measured for each mussel - dry wt of mantle/dry wt of all tissue. If comparisons of gonadal indices based on weight detect differences among sites, the fixed samples will be examined histologically and reproductive indices will be determined and compared - see 8. Contracts, below.

Byssal thread production rates can assess physiological impact , and indicate recovery if rates change after treatments. In 1992, live mussels were collected from 6 oiled and 3 unoiled mussel beds in PWS and their byssal thread production measured. Subsamples were taken for GC/MS analysis of HC burdens. Later in 1992, live mussels were collected from 4 different specific subsites at each of 2 oiled mussel beds, along with sediment samples taken from directly beneath each mussel sample. These mussels were also tested for byssal thread production. Analysis of results from this work is partially complete; GC/MS analyses is scheduled to be done in spring of 1993.

4. **Alternatives:**

The only reasonable alternatives to the proposed continued chemical monitoring of oiled PWS and GOA mussel beds are minor method variations.

5. **Location:**

Prince William Sound and Gulf of Alaska area impacted by *Exxon Valdez* oil.

6. **Benefits:**

This project will provide data on the efficiency of natural recovery processes and the efficacy of on-site cleaning or manipulation to hasten return to background HC levels.

Documentation of the level of hydrocarbons in oiled mussel beds or recovery of oiled mussel beds is necessary to evaluate continued linkage to injury seen in consuming species - harlequin ducks, black

oystercatchers, and other higher consumers, and will provide necessary information for human subsistence purposes.

7. **Technical Support:**

With the exception of 8., below, NOAA's Auke Bay Laboratory and the National Park Service will provide all technical support.

8. **Contracts:**

Contracts will be needed for field support (vessel and aircraft).

A contract(s) will be issued for histopathological examination of selected mussels from oiled mussel beds. These mussels have been chronically exposed to *Exxon Valdez* crude oil for 4 growing seasons and there is high probability of demonstrating abnormal pathology and altered reproductive indices when compared to mussels taken from unoiled mussel beds. Possibly two contracts will be needed - (1) a preliminary contract to examine mussels from the most heavily contaminated beds and compare with mussels from unoiled beds taken at least 2 different times during the growing season; and (2) if differences are seen, a second contract will be issued to examine mussels from a broader geographic area and mussels exposed to lower HC levels.

9. **Mitigation Measures:**

None identified in Section E.

10. **Literature Cited:**

Babcock, Malin. Hydrocarbon analyses of mussels and substrates/sediments collected from Prince William Sound, 1991: A special survey of oiled mussel beds. A report to the *Exxon Valdez* Oil Spill Trustee Council. 4 Nov., 1991.

Babcock, Malin, Gail Irvine, Stanley Rice, Patricia Rounds, Joel Cusick, and Christine Brodersen. 1993. Oiled mussel beds two and three years after the *Exxon Valdez* oil spill. Pp. 184-185, in *Exxon Valdez* Oil Spill Symposium. Sponsored by *Exxon Valdez* Oil Spill Trust. Counc., U AK Sea Grant Coll. Prog., Amer. Fish. Soc., AK Chap. Anchorage, Alaska.

Bauer, John, Wes Ghormley, Peter Montesano. 1992. Oiled Mussel Feasibility Study Interim Report (draft). Internal document. Oil Spill Response Center, Alaska Department of Environmental Conservation, 4241 B Street, Anchorage, Alaska 99503.

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

Larsen, Marie, Larry Holland, Dan Fremgen, Josefina Lunasin, Mona Wells , and Jeffrey Short. 1992. Standard operating procedures for the analysis of petroleum hydrocarbons in seawater, marine sediments, and marine faunal tissue at the Auke Bay Laboratory. Internal document. Auke Bay Laboratory, Alaska Science Center, NMFS, NOAA, 11305 Glacier Highway, Juneau, Alaska 99801-8626.

Manen, Carol-Ann, Jim Price, Sid Korn, and Mark Carls. NRDA Database Design and Structure. NOAA Technical Memorandum. (in preparation)

Rounds, Patricia, Stanley Rice, Malin M. Babcock, Christine C. Brodersen. 1993. Variability of *Exxon Valdez* hydrocarbon concentrations in mussel bed sediments. Pp. 182-183, in *Exxon Valdez* Oil Spill Symposium. Sponsored by *Exxon Valdez* Oil Spill Trust. Counc., U AK Sea Grant Coll. Prog., Amer. Fish. Soc., AK Chap. Anchorage, Alaska.

C. Schedules and Planning

March 1-June 17	Interim report for 1992, Symposium manuscript preparation, chemical analyses of samples taken 1992, planning, ordering supplies, 1992 data analyses, preparation of histopathological contract.
June 17-24	Vessel Charter to sample manipulated sites, primarily and, secondarily, sample survey sites. Personnel: Babcock, Rounds, Rice, and TBA.
June 25-Aug 15	Planning for August field trip, proposals for 1994 studies, chemical analyses, data analyses and interpretation.
August 15-21	Aircraft charters to conduct geographic sampling during low tide series. Personnel: Babcock, Rounds, TBA, TBA.
Aug 21-Sep 30	Chemical analyses, data analyses and interpretation, report preparation.

Personnel and Responsibilities:

NOAA:	
Stanley Rice	Principal Investigator
├─Malin Babcock	PI/Project Leader: PWS survey sampling
│ ├─Patricia Rounds	Project Leader: intensive sampling
│ ├─Christine Brodersen	Byssal thread production study
│ └─2 unidentified	PWS field crew
└─Jeffrey Short	Chem lab management/Quality assurance & control
└─Marie Larsen	Chemical analysis
└─chemists	Chemical analyses
NPS:	
Gail Irvine	Project Leader: GOA survey sampling
└─Joel Cusick	GOA survey sampling

Logistic Needs: Preliminary request for vessel charter has been initiated and will proceed under standard NOAA procedures. Standard NOAA contracting procedures will also be used to acquire helicopter and fixed wing aircraft for conducting the August sampling.

Analytical Logistics: Screening sediments by UV will cost about one tenth the cost of a sample analyzed by GC/MS. Using UV screening procedures will permit many analyses of substrates from a large number of sites, with follow-up GC/MS analyses on selected samples. The relative UV determinations will be calibrated relative to the GC/MS. Our budget for analyses will permit approximately 200 GC/MS samples to be analyzed (including samples from 1992 that remain unanalyzed) and about 400 samples screened by UV.

D. Environmental Compliance/Permit/Coordination Status

This is a field research project in which routine data collection, limited in context and intensity, will be done, and consequently is categorically exempt from requirement to provide an Environmental Impact Statement or Environmental Assessment.

E. Performance Monitoring

1. Management Plan

	NOAA	NPS
Overall Manager, Report Coordination	GS-14	
Field Logistics, Study design, Report Preparation . .	GS-12	GS-12
. . . . .	GS-11	GS-7
. . . . .	GS-9	
Chemical Quality Control.	GS-13	
Chemical Analyses	GS-11	
. . . . .	GS-11	
Chemical Analyses, Field Sampling	GS-9	

2. The following reports/manuscripts are anticipated:

1. Interim report, 1992 sampling	April 1993
2. Manuscript draft: High concentrations of hydrocarbons in mussels and underlying substrates two and three years after the *Exxon Valdez* oil spill	June 1993
3. Manuscript draft: Relationship of HC in mussels from contaminated substrate types three years after the *Exxon Valdez* oil spill	June 1993
4. Interim Report, 1993 sampling	November 1993
5. Report: Contamination recovery of mussels from oiled mussel beds where contaminated mussels and underlying substrates were removed in strips to increase natural flushing of the beds	April 1994
6. Report: Biological impacts of oiled substrates on mussels three and four years after the *Exxon Valdez* oil spill	April 1994
7. Tech Memo: Oil contamination in mussels from oiled mussel beds in PWS and the Kenai Peninsula, a geographic look with relative intensities	October 1994
8. Final Report:	6 months after HC analyses are completed.

F. Personnel Qualifications

STANLEY D. RICE

Education: Chico State Univ. B.A. 1966, M.A. 1968, Biological Sc.
Kent State Univ. Ph.D. 1971, Comparative Physiology

Experience: 1971-present. Researcher, Auke Bay Laboratory, National Marine Fisheries Service, Juneau, Alaska. Over 65 publications, most with oil toxicity and oil impacts to fish and invertebrates. Field, lab, and analytical expertise with hydrocarbons and effects. Studies have included field toxicity tests in Port Valdez, acute and long term toxicity tests, physiological impacts - including growth and reproduction. In 1986, became program manager for Habitat Investigations at ABL. Duties include management of all habitat related research at ABL, from parasite studies, logging impacts, oil toxicity exposures, to chem lab analyses. Program averaged about 24 man years of effort up to 1989. Management of budgets, staff, proposals, and research were part of my duties, plus continuation as a researcher on specific projects.

After the *Exxon Valdez* oil spill, I became responsible for management and coordination of all Damage Assessment studies from ABL, including multispecies trawling assessments and salmon impact studies by other ABL program units. I managed about 50 man years of effort in 1989 (Habitat programs plus *Exxon Valdez* Damage Assessment activities), and about 35-45 in 1990 and 1991. I was responsible for opening a NMFS office in Cordova for the summer of 1989, and spent the majority of summer 1989 in Cordova and PWS. I was a primary source of input to the management team during the first 6 months of the spill. In addition to management activities, I have continued to participate as a researcher in some studies, including sediment-HC surveys and oiled mussel beds in 1992.

Honors: Outstanding Performance ratings in 1989 and 1990, NOAA Unit Citations for work on the IXTOC oil spill in 1979, and EXXON VALDEZ oil spill of 1989. Federal Employee of the Year nominee in Juneau in 1981 and 1989. Best Paper awards in 1982 and 1984 from ABL, and best paper nominee for NMFS in 1990.

Relevant Publications: Over 50 on oil exposures, including several major reviews on oil effects to fish and invertebrates. This includes the first major review of oil literature relevant to Alaska, in 1974, which was prepared as source material for the environmental impact statement for the marine aspects of the Trans-Alaska Pipeline.

MALIN M. BABCOCK

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

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

After the *Exxon Valdez* oil spill, I was co-principal investigator for the EVOS Coastal Habitat Study "Pre-spill and post-spill hydrocarbon concentrations in mussels and sediments in Prince William Sound", becoming Principal Investigator of this project in 1991 and 1992; was also Principal Investigator for the NRDA study "Injury to Oysters" in 1989. In 1991, I participated in the interagency planning for investigating an evolving problem - that of the effects of contaminated mussel beds on higher consumer organisms, and led the preliminary field effort for identifying these beds and sampling parameters to establish the extent and intensity of petroleum hydrocarbons contamination. This effort has provided a basis for this ongoing study. Along with other members of ABL's Habitat Investigations team, 1989, I assisted AK Dept. of Fish & Game staff in study design and methods for their species oriented areas of concern and continue to be a resource scientist in this area. Staff under my direct supervision are involved in many aspects of EVOS NRDA and Restoration program - several NRDA studies, training all NRDA study personnel in sampling for hydrocarbons, the NRDA/Rest database, sample custody and tracking, etc.

Honors: Outstanding Performance ratings in 1988 and 1989; NOAA Unit Citation for work in the *Exxon Valdez* oil spill 1989; Federal Employee of the Year, Juneau, Alaska in 1985.

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

GAIL V. IRVINE

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

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

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

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

PATRICIA M. ROUNDS

Education: University of Alaska Fairbanks; B.S. Biological Science 1966
Graduate work at U of A Fairbanks, U of A Southeast, University of British Columbia

Experience: 1986 - present. Researcher, Auke Bay Laboratory, National Marine Fisheries Service, Juneau, Alaska. As co-principal investigator of NRDA study Subtidal 3, I and was responsible for field logistics and sample collection and assisted in data analysis and report preparation. I also assisted other NRDA projects in field collections. In 1992, I participated in study design, field work, and proposal preparation for this project, formerly restoration Project R103). Other areas of research have been habitat requirements of juvenile red king crab and sockeye salmon stock separation using parasites.

Honors: Outstanding Performance ratings 1988 (Special Act Award), 1989 and 1991. NOAA Unit Citation for work in the *Exxon Valdez* oil spill, 1989.

CHRISTINE C. BRODERSEN

Education: University of Washington, B.S. Zoology 1971
Graduate work, U of A Southeast

Experience: 1974 - present. Researcher, Auke Bay Laboratory, National Marine Fisheries Service, Juneau, Alaska. Twelve years of oil toxicity research on sensitivity of Alaskan marine life to Alaskan crude oils, particularly larval and juvenile crustaceans. Since the *Exxon Valdez* oil spill I have trained personnel from state and federal agencies involved in the NRDA process in procedures for taking and transporting scientifically valid hydrocarbon-analysis samples and maintaining legal defensibility of those samples.

Honors: NOAA Unit Citation for work in the *Exxon Valdez* oil spill 1989.

Relevant Publications: 13 publication and reports - 9 on effects of exposure to petroleum hydrocarbons on various Alaskan species of fish and shellfish. Over 8 public presentations of scientific studies.

Project Description: Completion of the River Otter portion of the oiled mussel bed project (R 103).

Budget Category	Approved 1-Oct-92 28-Feb-93	Proposed* 1-Mar-93 30-Sep-93	Total FY 93	FY 94	FY 95	FY 96	FY 97	Sum FY 98 & Beyond
Personnel	$23.0	$0.0	$23.0					
Travel	$1.0	$0.0	$1.0					
Contractual	$0.0	$0.0	$0.0					
Commodities	$0.0	$0.0	$0.0					
Equipment	$0.0	$0.0	$0.0					
Capital Outlay	$0.0	$0.0	$0.0					
Sub-total	$24.0	$0.0	$24.0	$0.0	$0.0	$0.0	$0.0	$0.0
General Administration	$3.5	$0.0	$3.5					
Project Total	$27.5	$0.0	$27.5	$0.0	$0.0	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)	0.3	0.0	0.3					

Amounts are shown in thousands of dollars.

Budget Year Proposed Personnel:

Position	Months Budgeted	Cost	Comment

* FY 93 is a transition year from the previously used oil fiscal year to the federal fiscal year.

17-Jul-92

1993

Project Number: 93036
Project Title: Oiled Mussel Beds
Sub-Project: River Otters
Agency: AK Dept. of Fish & Game

FORM 3A SUB-PROJECT DETAIL

Project Description: Recovery monitoring and restoration of intertidal oiled mussel beds impacted by the *Exxon Valdez* oil spill in Prince William Sound and along the coastline of northwestern Gulf of Alaska.

Budget Category	Approved 1-Oct-92 28-Feb-93	Proposed* 1-Mar-93 30-Sep-93	Total FY 93	** FY 94	FY 95	FY 96	FY 97	Sum FY 98 & Beyond
Personnel	$161.7	$157.5	$319.2	$127.0	$135.0			
Travel	$14.5	$29.0	$43.5	$17.0	$17.0			
Contractual	$12.5	$115.0	$127.5	$75.0	$40.0			
Commodities	$49.2	$33.6	$82.8	$20.0	$15.0			
Equipment	$28.0	$38.0	$66.0	$4.0	$10.0			
Capital Outlay	$0.0	$0.0	$0.0	$0.0	$0.0			
Sub-total	$265.9	$373.1	$639.0	$243.0	$217.0	$0.0	$0.0	$0.0
General Administration	$25.2	$31.7	$56.9	$24.3	$23.1			
Project Total	$291.1	$404.8	$695.9	$267.3	$240.1	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)	3.1	2.8	5.9	1.9	2.2			

Amounts are shown in thousands of dollars.

Budget Year Proposed Personnel:

Position	Months Budgeted	Cost	Comment

For detail, see 3A & 3B forms

* FY 93 is a transition year from the previously used oil fiscal year to the federal fiscal year. This * column includes funding ONLY for 1 March - 30 September 1993. ** includes closeout funding = $117K.

Project Number: 93036
Project Title: Oiled Mussel Beds
Agency: National Oceanic & Atmospheric Admin.

FORM 2A PROJECT DETAIL

Project Description: Recovery monitoring and restoration of intertidal oiled mussel beds impacted by the *Exxon Valdez* oil spill in Prince William Sound, Alaska.

Budget Category	Approved 1-Oct-92 28-Feb-93	Proposed* 1-Mar-93 30-Sep-93	Total FY 93	** FY 94	FY 95	FY 96	FY 97	Sum FY 98 & Beyond
Personnel	$138.7	$126.0	$264.7	$92.0	$135.0			
Travel	$13.5	$23.0	$36.5	$11.0	$17.0			
Contractual	$12.5	$70.0	$82.5	$30.0	$40.0			
Commodities	$49.2	$26.0	$75.2	$13.0	$15.0			
Equipment	$28.0	$34.0	$62.0	$2.0	$10.0			
Capital Outlay	$0.0	$0.0	$0.0	$0.0	$0.0			
Sub-total	$241.9	$279.0	$520.9	$148.0	$217.0	$0.0	$0.0	$0.0
General Administration	$21.7	$23.8	$45.5	$15.9	$23.1			
Project Total	$263.6	$302.8	$566.4	$163.9	$240.1	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)	2.8	2.2	5.0	1.4	2.2			

Amounts are shown in thousands of dollars.

Budget Year Proposed Personnel:

Position	Months Budgeted	Cost	Comment
Zoologist GS11	7.0	$35.6	
Chemist GS11	6.0	$30.5	P. I., Co-P. I., & Fishery Biol. = no cost
Chemist GS11	5.0	$25.4	ABL contribution = approximately $28.5K
Chemist GS09	7.0	$28.6	
Program Manager GS12	1.2	$5.9	

* FY 93 is a transition year and costs in * column are ONLY Mar 1 - Sept 30, 1993

**FY94 includes closeout costs of $80.0K

20-Aug-92

Project Number: 93036
Project Title: Oiled Mussel Beds
Sub-Project: Prince William Sound
Agency: National Oceanic & Atmospheric Admin.

FORM 3A SUB-PROJECT DETAIL

1993

		Proposed
Travel:	12 staff RT Juneau to Prince William Sound 6 Staff to inter and intra agency meetings and symposia.	$23.0
Contractual:	Vessel ($11.0) and aircraft ($36.0) charter, data entry ($3.0), histopathology contract ($20.0)	$70.0
Commodities:	Chemicals ($16.0), chemistry lab supplies ($3.5), field gear ($1.0), sampling tools ($1.0) office supplies ($0.5), mapping supplies ($1.5), publication costs ($1.0), film ($0.5), computer software (i.e., Excel) and upgrades ($1.0)	$26.0
Equipment:	Radios ($2.0), computer ($7.0), computer hardware upgrades ($2.0), GPS unit ($3.0), fFluorescence detector ($20.0).	$34.0

Project Description: Recovery monitoring and restoration of intertidal oiled mussel beds impacted by the *Exxon Valdez* oil spill along the coastline of northwestern Gulf of Alaska.

Budget Category	Approved 1-Oct-92 28-Feb-93	Proposed* 1-Mar-93 30-Sep-93	Total FY 93	** FY 94	FY 95	FY 96	FY 97	Sum FY 98 & Beyond
Personnel	$0.0	$31.5	$31.5	$35.0				
Travel	$0.0	$6.0	$6.0	$6.0				
Contractual	$0.0	$45.0	$45.0	$45.0				
Commodities	$0.0	$7.6	$7.6	$7.0				
Equipment	$0.0	$4.0	$4.0	$2.0				
Capital Outlay	$0.0	$0.0	$0.0	$0.0				
Sub-total	$0.0	$94.1	$94.1	$95.0	$0.0	$0.0	$0.0	$0.0
General Administration	$0.0	$7.9	$7.9	$8.4	$0.0	$0.0	$0.0	$0.0
Project Total	$0.0	$102.0	$102.0	$103.4	$0.0	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)	0.0	0.6	0.6	0.5				

Amounts are shown in thousands of dollars.

Budget Year Proposed Personnel:

Position	Months Budgeted	Cost	Comment
Marine Ecologist GS12	2.0	$13.0	
Biological Technician GS7	4.0	$12.6	
NPS Prog. Manager	1.2	$5.9	

* FY 93 is a transition year from the previously used oil fiscal year to the federal fiscal year

**FY94 includes closeout costs of $37.0K

20-Aug-92

Project Number: 93036
Project Title: Oiled Mussel Beds
Sub-Project: Gulf of Alaska
Agency: Dept. of Interior, National Park Service

FORM 3A SUB-PROJECT DETAIL

1993

		Proposed
Travel:	4 staff RT Juneau to Gulf of Alaska 1 Staff to inter and intra agency meetings and symposia.	$6.0
Contractual:	Vessel ($40.0) and aircraft ($5.0) charter	$45.0
Commodities:	Field gear, sampling tools and supplies; Office supplies, mapping supplies, publication costs, film; Computer software (i.e., Excel) and upgrades	$7.6
Equipment:	Radios, computer hardware upgrades, GPS unit	$4.0

Project Description: Completion of the River Otter portion of the oiled mussel bed project (R 103).

Budget Category	Approved 1-Oct-92 28-Feb-93	Proposed* 1-Mar-93 30-Sep-93	Total FY 93	FY 94	FY 95	FY 96	FY 97	Sum FY 98 & Beyond
Personnel	$23.0	$0.0	$23.0					
Travel	$1.0	$0.0	$1.0					
Contractual	$0.0	$0.0	$0.0					
Commodities	$0.0	$0.0	$0.0					
Equipment	$0.0	$0.0	$0.0					
Capital Outlay	$0.0	$0.0	$0.0					
Sub-total	$24.0	$0.0	$24.0	$0.0	$0.0	$0.0	$0.0	$0.0
General Administration	$3.5	$0.0	$3.5					
Project Total	$27.5	$0.0	$27.5	$0.0	$0.0	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)	0.3	0.0	0.3					

Amounts are shown in thousands of dollars.

Budget Year Proposed Personnel:

Position	Months Budgeted	Cost	Comment

* FY 93 is a transition year from the previously used oil fiscal year to the federal fiscal year.

17-Jul-92

1993

Project Number: 93036
Project Title: Oiled Mussel Beds
Sub-Project: River Otters
Agency: AK Dept. of Fish & Game

FORM 3A SUB-PROJECT DETAIL

93038

EXXON VALDEZ 1993 SHORELINE RESTORATION SURVEY

A. SUMMARY INFORMATION

PROJECT No. 930380

Project type: Monitoring

Project leader: Ernest Piper, ADEC

Lead agency: Alaska Department of Environmental Conservation

Cooperating agencies: USFWS, USFS, ADF&G, ADNR, NMFS, U.S. Coast Guard

Cost: $520.7

Project start-up: June 1, 1993

Completion: September 30, 1993

Area of project: 52 sites in Prince William Sound and Gulf of Alaska

B. INTRODUCTION

On June 13, 1992, the federal and state on-scene coordinators declared the Exxon Valdez oil spill response complete according to federal and state pollution control guidelines, regulations, and statutes. State pollution control regulations at 18 AAC 75.327 require cleanup to the satisfaction of the department, until the technical capability to remove the pollution is exhausted, or until further removal would cause more harm than leaving the pollution in place.

Similar federal guidelines, especially those in the U.S. Coast Guard's Marine Safety Manual, also require the on-scene coordinator to consider whether the cost of continued removal is disproportionate to the benefit that would be achieved. Those thresholds were reached, according to state and federal cleanup authorities, although there remained persistent oiling conditions at various locations.

The final response survey and remediation program of 1992, conducted jointly by the State of Alaska, the United States, and Exxon, documented the remaining known areas of persistent oiling. Surface oiling consisted primarily of asphalts, tars, and heavily weathered emulsion, often bound up with sediments of various types. Subsurface oiling consisted of areas of fine sediments contaminated to varying degrees with hydrocarbon residue.

The Exxon Valdez Trustee Council has allocated up to $520,000 from the settlement trust in 1993 to continue shoreline surveys of the affected area. The Alaska Department of Environmental Conservation (ADEC) has been directed to manage the survey on behalf of the trustees.

During the response phase, the on-scene coordinators from the U.S. Coast Guard and the State of Alaska operated under broad authority to control and abate pollution under federal and state law.

The 1993 survey is being conducted for the purposes of restoration, not for containment and cleanup. Therefore, the survey's objectives are based on the Exxon settlement agreements, the associated federal court order, and the specific resource management authorities held by the six state and federal trustee agencies.

State and federal pollution control statutes and regulations are designed to give the governments broad authority to expend funds, direct response actions, and conduct other operations that will protect resources and the public health from imminent threats from pollution.

This project, and its associated remediation work, differ in two primary ways: (a) any work must be tied to an injured resource or service under trustee authority, and (b) the project manager, unlike an on-scene coordinator, may expend project funds only on those activities specifically approved by the Trustee Council.

If the survey teams find seriously oiled areas that were either overlooked, or that have been exposed due to changing shoreline profiles, ADEC and/or the U.S. Coast Guard could apply pollution control authority and reopen the response on a broad basis. However, that type of action is outside the scope and the funding of this project.

The original project description approved by the Trustee Council authorized the survey teams to monitor shorelines "to ensure recovery is proceeding at an acceptable rate and that winter stroms have not brought subsurface oil to the surface. Shorelines treated in 1992, and other potentially oiled sites, need to be evaluated to determine if shorelines responded to treatment , or if additional treatment is required to restore resources and services."

C. Project description

1. Target resources and services

The 1993 survey will provide information that will help trustee agencies design other restoration projects. The project team may also conduct limited remediation of shorelines. It is not designed to address injury to a single resource or service.

Specifically, the survey will provide information regarding persistent oiling at or near critical habitats being considered for protection, persistent oiling at or near food sources of injured species (such as sea otters, oyster catchers and other shore birds), and persistent oiling that may inhibit or eliminate subsistence hunting and fishing at or near a given site. The survey information will also be used to augment data from other restoration projects.

Limited remediation efforts are expected to consist of breaking up or exposing pockets of weathered oil, emulsion, and sediments that have stabilized or consolidated into conditions resistant to natural degradation. Removing or accelerating degradation of the oil is expected to reduce visual effects of pollution and aid recolonization of affected areas by resident plants and animals.

2. Objectives

The shoreline survey of 1993 is similar to, and smaller than, previous shoreline surveys conducted by state and federal agencies in 1989, 1990, 1991, and 1992. The 1993 survey is designed to

provide another series of data points regarding the conditions on the shorelines affected by the spill. The survey team will observe and record oiling and other conditions so that they can be compared with similar types of information collected during the response.

The crew will collect information that will allow the trustee agencies to determine whether oil is remobilizing, whether it contains toxic fractions, and whether its continued presence is inhibiting natural recovery of the injured resources, or hindering services and activities injured by the oil spill.

Specifically, the survey team will:

(1) Observe and record oiling conditions at selected sites;

(2) Observe and record geomorphological observations that will allow comparison with data gathered in previous seasons;

(3) Observe and record selected biological information;

(4) Observe and record oiling conditions, surface and subsurface, at oiled mussel beds, if such work is requested by directors of project 95036 (mussel bed project);

(5) Collect appropriate samples of weathered oil and oiled sediment for further analysis;

(6) Break up, scatter or remove weathered oil that appears to have stabilized into states highly resistant to degradation, and appears to threaten or inhibit recovery of an injured resource or service;

(7) Gather any other data that will allow the trustees to decide if more substantial remediation is necessary for the purposes of restoration.

3. Methods

a. Site selection methodology

ADEC has compiled a preliminary list of 52 shoreline subdivisions to be surveyed roughly from June 1 - August 15, 1993. This base list will be expanded after review and comment by communities, the Trustee Council, and other state and federal agencies. The sites are identified using the segment and subdivision classification system developed and used by the state and federal response agencies during the cleanup and containment phase.

The base list was compiled using the same general methodology used by the state, the federal government, and Exxon to select survey sites for the 1990, 1991, and 1992 surveys.

Each year's survey was based primarily on the most recent oiling information available for each site. An interagency group, which included Exxon, would compare data and develop a consensus about whether a given site showed enough evidence of oiling to justify an

additional survey visit. The primary criterion for selecting a site for survey was whether the last recorded oiling data suggested that more cleanup might be needed. Most existing survey data, therefore, is biased towards cleanup standards, and cannot be used as the basis for a true fate-and-effects study.

This methodology was not intended to produce a record of all potential persistent oiling across the entire spill area. It will, however, provide an additional year of data from known areas of persistent oiling.

ADEC selected the first 52 sites for the 1993 survey by examining oiling information from the 1992 FINSAP, or Final Shoreline Assessment Project, conducted for the response. The department also used data generated solely by and for ADEC, such as the Daily Shoreline Assessment reports the state's spill monitors prepared each day at each site they visited.

ADEC spill responders, using best professional judgment, listed for future survey those sites that showed:

(1) Continued surface or subsurface oiling over a significant portion of the subdivision;

(2) Areas of moderate to serious oiling, based on the ad hoc classification system used during the survey (definitions ranged from SOR -- surface oil residue - to OP and HOR -- oil-saturated sediments and high oil residue);

(3) Areas in which several years of oiling data suggested that oil might remobilize and create new visible oiling in a subsequent year, regardless of the previous year's cleanup efforts;

(4) Areas of emerging concern, such as the heavily oiled mussel beds which had received little or no cleanup over time;

(5) Areas of specific and consistent concern on the part of an agency, landowner, or nearby community.

b. Shoreline survey methodology

The survey will include teams consisting of 4-8 resource specialists approaching shorelines by a base vessel and skiffs. Methods will include primarily passive observation and mapping.

At sites where there existed moderate to heavy subsurface oiling in 1992, survey members may dig a series of shallow (average 5-15 cm; occasionally up to 40 cm) pits to delineate and describe the extent and composition of oiled sediment lenses.

Survey crews will use small hand tools such as trowels, rakes, and long-bladed clam shovels.

Shore survey crew members will walk each shoreline in the survey and:

(1) Make observations at specific sites or in subdivisions with a history of persistent oiling, according to existing data;

(2) Examine areas having the physical characteristics of places where oiling has been persistent, such as "wave shadows," boulder fields, and other areas protected from significant wave energy or weather;

(3) Examine areas in which state monitors previously reported oiling, but the response survey crews did not completely survey or "follow" the oiling to determine its true extent;

(4) Dig discovery and delineation pits in areas where subsurface oiling was previous reported;

(5) Collect samples, as appropriate;

(6) Record the absence or presence of oiling, describing it according to established terms (Attachment 4);

(7) Describe the extent of the oiling, as much as possible, on and below the surface;

(8) Record the absence, presence, and/or relative abundance of common shoreline plants and animals;

(9) Record beach profiles and the general gemorphological setting by drawing simple sketch maps and listing any striking or unusual features;

(10) Record the general subsurface profile of the beach based on pits dug to the point where fine sediments prevail;

(11) Make a photographic and/or video record of each site survey;

(12) Describe any remediation action, if any, taken at the site;

(13) Record basic wind, weather, and tidal conditions at the time of the survey.

c. Remediation methodology

The survey crews may, depending on conditions, conduct limited remediation for the purposes of restoring a site, restoring the use of a given shoreline, or to help speed natural recovery.

Remediation under this project and budget is limited to work that can be performed by the survey team, using hand tools such as shovels, pry bars, trowels, etc. Methods are limited to those previously approved by the federal and state on-scene coordinators during the Exxon Valdez response phase.

The project manager is authorized to write work orders for more substantial restoration remediation, in consultation with the resource agencies and the upland landowner. The Trustee Council, in consultation with the Chief Scientist and the Public Advisory Group, would make the decision to alter, ignore, or implement the additional work orders based on its collective resource management and policy authority.

The project manager, in consultation with the resource agencies and the upland landowner, may carry out limited remediation after considering the following:

(1) The nature and extent of the oiling;

(2) The resources at risk in the area;

(3) The uses of the area that may be impaded or eliminated by the presence of the oiling;

(4) The probable effect of leaving the oiling in place;

(5) The ability of the crew to complete the work safely and in a timely manner;

(6) The ability of the crew to control, contain, or recover any release of mobile oil caused by the work;

(7) The persistence or resilience of the oiling condition;

(8) The relationship of the oiling to a resource or use under Trustee Council agency authority;

(9) Other environmental and regulatory considerations, such as those described at 18 AAC 75.327, or in appropriate federal pollution control and abatement standards or statutes.

Generally, the crew will attempt to remove or break up stable, visible oiling such as asphalt patches and tar mats. These are assumed to be incompatible with uses of the shoreline and the resources.

It is further assumed that removing or breaking up these stable, slow-degrading oiling conditions is compatible with basic restoration options, such as manipulating a resource to speed recovery, or creating conditions that accelerate or aid natural recovery.

Remediation of subsurface oiling conditions is a more complex resource management and logistical issue. The survey team's responsibilities regarding subsurface oiling are:

(1) Delineate and describe, as accurately as possible, the extent and nature of the oiling;

(2) Expose the oiled sediments to speed natural degradation, provided the action does not create an uncontrollable release, or otherwise put a resource or use in imminent danger of further injury;

(3) Remove moderate- to heavily oiled sediment that have been exposed, and that may create an uncontrollable release, or put a resource or use in imminent danger if left in the disturbed condition;

(4) Write work orders for additional work, if feasible, and submit to the Trustee Council for consideration.

The survey crew is equipped and authorized to conduct spot remediation. This is defined as:

(1) Work that can be completed by existing crew within 1 complete tide cycle;

(2) Work that does not result in a release of mobile, silver or brown sheen, unless under the guidance of the U.S. Coast Guard;

(3) Work that does not obviously threaten a given resource.

The survey crew will depend on hand tools and manual labor. Remediation will consist primarily of breaking up stabilized asphalts and tar patches, exposure and aeration of sediments, and removal of sediments within reasonable limits of environmental safety and cost effectiveness.

The decision to undertake spot remediation will be made by consensus of the resource managers on site, using best professional judgment.

The project manager will resolve disputes that are technical in nature, e.g., a dispute over the difference between "spot" and "substantial" remediation, the abilities of the crew to perform a given task, the probability that an uncontrollable or sustained release of oil may occur, etc.

Determination of the biological threat (or the threat to a use or service) caused by conducting remediation or leaving oiling in place rests with the manager for the resource in question. If the resource managers on site cannot reach consensus on the need for, or the likely effects of, spot remediation, no work will take place at the site and the issue will be referred to the Trustee Council (or to the Restoration Team, by direction of the Trustee Council).

Unless an emergency exists, the survey team will not undertake substantial restoration. Substantial remediation will require a separate work order, separate Trustee Council authorization, and may require separate funding.

Substantial remediation is defined as:

(1) Work that cannot be completed or completely stabilized by one work crew within one tide cycle;

(2) Widespread removal of sediments;

(3) Use of tools, equipment, or methods not listed in this plan.

The project manager, in consultation with the resource agencies and the appropriate landowner, may write additional work orders for substantial remediation. The work orders will be screened by the Restoration Team and submitted to the Trustee Council.

4. Alternatives

a. Site selection

The original instructions from the Trustee Council stated that the 1993 survey should follow, as much as possible, the methodologies developed during the response phase. The rationale behind this instruction was that data would be more consistent over time.

The response survey methodology was biased in favor of cleanup: Areas of oiling that were unlikely candidates for cleanup were dropped from subsequent survey lists. Cleanup officials used this method for a variety of reasons, including cost, pollution control regulations, logistical considerations, and best professional judgment about the effects of weather and wave energy, photodegradation, biodegradation, and other natural factors. The basic rationale was to survey only those areas where it appeared persistent according to the last, most recent available data. Survey crews generally did not return to areas where cleanup officials had determined that cleanup had reached its practical limit the previous summer.

The initial list for the 1993 restoration survey was generated by ADEC at the close of the response phase in 1992. Therefore, it has

the same bias as previous surveys. Realizing that such a methodology may not be broad enough to produce all the data that may be needed for restoration purposes, the lead agency has made provisions for adding additional sites to the survey, if necessary.

Sites may be added at the request of a trustee agency, a landowner, or member of the public. Sites will be added when:

(1) Agencies request specific samples or specific observations related to restoration;

(2) The requesting party presents evidence or information that suggests there may be oiling of significant nature that has been overlooked or not discovered;

(3) The resource or use in question warrants more extensive scrutiny than originally proposed;

(4) The Trustee Council instructs the lead agency to add aites for public policy reasons.

b. Shoreline survey methodology

Physically walking the shorelines is a practical and cost-effective way to actually discover oiling, especially at this stage, when most oiling conditions are either buried or obscured and in discrete patches scattered largely at random.

The use of mechanical equipment to aid the surveys is probably not a cost-effective alternative. It would increase the cost and effort of staging, transportation, operations, maintenance, training, fueling and/or powering such equipment. Given the random and relatively small size of the oiling previously recorded in 1992, mechanical equipment would probably be too cumbersome, and could not be controlled to the degree of sensitivity needed to find and deliniate oiling conditions.

ADEC, NOAA, and an Exxon contractor conducted additional, limited shoreline surveys throughout the course of the response. These surveys dealt with fate-and-effects, geomorphological profiles, and other subjects to a higher level of precision than the joint, cleanup-oriented surveys. Most of these secondary studies included more rigorous use of transects and other methods. However, many of these sites fell out of the cleanup-oriented surveys because oiling was increasingly diminished by cleanup or weathering. Therefore, for purposes of finding oil, revisiting these sites and running the transects is not practical.

Most, if not all, of the 1993 survey sites have not been surveyed in a more rigorous manner. Running transects at these sites may be useful in the long run, but the data generated in 1993 by this method would not have much relevance to survey data from previous years. It would also require more time, and more expense.

c. Remediation methods

Remediation beyond the simple, manual methods approved during the response are not within the scope of the project, its budget, or the capability of the small crew and the vessel on which it will be based.

In the event that more serious oiling is discovered and the Trustee Council decides to execute more detailed and extensive work orders at selected sites, this project makes provisions for assessing alternative sites and methods for remediation.

Private landowners, local governments, and the public may submit additional requests for both spot and substantial remediation to the Trustee Council. The requests should be as specific as possible, including:

(1) The precise location of the site, preferably by Exxon Valdez segment and subdivision designation;

(2) Evidence of oiling at the site, preferably described by its extent and nature;

(3) A brief description of how the oiling is causing further injury to a resource or use, or how the oiling is impeding or eliminating a known use of the site.

Requests for spot remediation will be immediately referred to the project manager for determination in the field. The project manager may fulfill the requests for spot remediation if:

(1) The request is within the general scope of restoration options identified by the Trustee Council;

(2) The request is within the ability of the crew to perform the work according to the technical criteria listed in this plan;

(3) The proposed work would not substantially impede the ability of the crew to complete its planned tasks within established work schedules;

(4) The proposed work would not expose the survey team to undue risk;

(5) The proposed work would not, in the best professional judgment of the resource managers, cause further injury to other natural resources or services injured by the oil spill.

If the project manager decides to forego the work based on any of these criteria, the request will go back to the Trustee Council for final determination.

Requests for substantial remediation (including remediation using equipment, products, or techniques not listed in this plan) will be

immediately referred to the project manager for determination of the technical feasibility of the plan, including, but not limited to, consistency with federal and state chemical testing protocols and product listings, and consistency with federal and state pollution abatement and control standards and statutes.

The resource agencies will conduct a simultaneous evaluation of the request based on its environmental and resource management implications.

The project manager will refer the request, with appropriate recommendations, to the Trustee Council.

5. Location

See Attachments.

6. Benefits

Survey information concerning the absence, presence, nature, extent, and persistence of oiling will benefit resource agencies planning or undertaking restoration activities. It will benefit the public by providing information about the conditions of the public lands and waters in the spill area.

Reduction or elimination of persistent surface oiling will improve the visual appearance of the shorelines, reduce some impacts to subsistence and commercial uses of the shorelines, improve the quality of public lands and waters in the immediate vicinity of

remediation, improve some conditions necessary for normal recolonization and succession of shoreline plants and animals, and reduce the potential of continued contamination.

7. Technical support

Technical suuport of the project is limited primarily to entry and manipulation of the data in the Restoration Team's data base.

8. Contracts

a. Vessel

The State of Alaska has received and opened bids for a research vessel. Procurement officers are currently reviewing the bids to determine if they are responsive. Award of the bid is contingent upon physical inspection of the vessel by the United States Coast Guard and the Department of Environmental Conservation.

b. Air

State of Alaska procurement procedures allow the lead agency to arrange aircraft charters as needed, providing the agency has solicited three written price quotations from qualified vendors. The lead agency has solicited these price quotations for both fixed-wing aircraft and helicopters, as some sites in the survey cannot be reached by vessel either because of shoreline topography, prevailing sea conditions, or other considerations. Aircraft may also be used for some sites in the event of unforeseen and/or unavoidable weather or scheduling problems that may arise.

c. Professional services

The lead agency plans to issue a contract for the services of a qualified coastal geologist to ensure proper field procedures, data collection, and recording by field staff. The coastal geologist will also be responsible for interpreting relevent data and preparing a summary report to be included in this project's final report.

Each survey team on previous surveys included a geomorphologist hired by Exxon. The cost-effectiveness of having a fulltime geomorphologist in the field at all times is questionable in 1993, given the fact that the shoreline profiles and other geomorphological descriptions of the sites have been previously established, methods and objectives for collecting additional information have been established, and no significant disruption of the shorelines during remediation is planned.

The lead agency plans negotiate a sole-source contract with one or both of the coastal geologists who designed and supervised the State of Alaska's shoreline surveys, or retain the services of the leading coastal geologist used by NOAA and the Coast Guard during the response. These are: Dr. Erich Gundlach, the state's initial consultant, and a coastal geologist specializing in the fate and effects of spilled oil; Dr. James Gibeaut, a coastal geologist who worked with Dr. Gundlach, and later designed and supervised additional subsurface oiling surveys for the state; Dr. Jacqui Michel, a coastal geologist who conducted similar surveys for NOAA.

d. Waste management

State procurement rules allow the lead agency to contract for limited disposal on an as-needed basis, due to the small amounts of waste that might be generated, and the limited number of qualified vendors in Southcentral Alaska.

9. Mitigation measures

The potential adverse environmental effects of the proposed survey include, primarily:

a. possible disruption of resident or migratory wildlife species;

b. extremely localized disruption of resident shoreline plants and animals;

c. uncontrolled or unmonitored releases of mobile oil or emulsion due to remediation activity;

d. localized destabilization of shorelines due to remediation activity.

Previous survey and remediation activity was conducted under a variety of special, non-permit guidelines and requirements established by the respective resource managers in the spill area. These included buffer zones protecting nesting or rearing wildlife, anadromous fish, or marine mammals from work crews, aircraft, and vessel approaches. Shoreline activity was also governed, in part,

by guidelines that limited or prohibited disruption of shoreline plants and animals.

The lead agency is soliciting similar guidance from other agencies in 1993, based on the type, scope, and locations of the proposed activities. Compliance will be monitored by the project manager, as well as by the respective agencies, as each trustee agency has a budget for a field representative.

The survey team also includes representatives from the federal and state agencies with primary responsibility for marine pollution control, the United States Coast Guard and the Alaska Department of Environmental Conservation. These agency representatives will be charged with determining whether remediation proposals meet federal and state pollution requirements; in particular, the Coast Guard will provide guidance concerning the likelihood of uncontrolled or persistent releases of oil into the water due to remediation.

Upland landowners, both public and private, will have the opportunity to observe the survey activities and provide guidance to the project manager. All sites scheduled for survey will be reviewed by state, federal, and private land managers with expertise in identification and protection of archeological and cultural resources. The project manager will solicit guidance from Alaska Native governments and village leaders and elders regarding any special cultural sensitivities of which the crew should be aware.

10. Literature

This project plan is based on design and scope of previous surveys, including data reports, wildlife mitigation measures, composition and nature of oiling, descriptions, terms, and definitions in Exxon Valdez response files. These files include correspondence, memoranda, data files that have not been fully subjected to QA/QC procedures, notes, internal agency reports, minutes and notes from response organization meetings, and summaries and proceedings of science and policy conferences organized by the governments. The plan's authors also consulted restoration documents, including the summary of injury, papers presented at the February 1993 symposium, and general restoration planning documents.

11. Existing agency program

Each trustee agency, as well as the U.S. Coast Guard, are assigning agency staff to this project. Funding for each is provided in the project budget.

D. Schedules and planning

May 16 -- Project manager hired.

May 18 -- Open bids for vessel contract.

May 28 -- Submit draft survey plan to Restoration Team for review.

May 28 -- Submit site list to agencies, landowners, and the public for review and comment.

May 20 -- June 15 -- Obtain additional permits and authorizations, notify Alaska Regional Response Team.

June 20-28 -- First round of surveys

July 4 -- 15 -- Second round of surveys

August -- Finish surveys

September -- Assemble data, draft final report.

September 30 -- October 30 -- Conclude project.

E. Environmental compliance/permits/coordination

The lead agency requested a categorical exclusion for this project under National Oceanic and Atmospheric Administration rules governing research activity. NOAA issued a finding of no significant impact and granted the categorical exclusion.

The project manager has requested guidance based on this project plan from the Alaska Department of Natural Resources, the Alaska Department of Fish and Game, the Alaska Regional Response Team, and the U.S. Army Corps of Engineers. Depending on agency interpretations, the project may require a general land use permit (ADNR), a Title 16 permit (ADF&G), a Section 404, Clean Water Act permit (Corps of Engineers), and approval of the ARRT.

F. Performance Monitoring

Chain of command and decision-making processes are described elsewhere in this project plan.

The project manager will produce at the close of the project:

(1) A data report on a site-by-site basis;

(2) A segment summary report, describing the conditions and activities at each site in 1993, comparing them, if possible, with data from previous years;

(3) A narrative report, with appropriate maps and photographs, intended for distribution to the general public, describing the general condition of the shorelines surveyed, including any additional information deemed important by the respective trustee agencies and participants in the survey;

(4) Additional reports, summaries, data sets, photographs, video records, etc., that have been reviewed and properly organized.

G. Personnel qualifications

The agencies participating in the survey are expected to provide personnel with specific experience in shoreline surveys and operations during the Exxon Valdez response. The project manager is Ernest Piper, Alaska Department of Conservation. Mr. Piper has seven years senior management experience with the State of Alaska, including 18 months as special assistant to the Governor of Alaska on Exxon Valdez response operations, and 18 months as ADEC State On-Scene Coordinator for the Exxon Valdez response.

d. Data management

The EVOSRC GIS system uses Geo/SQL to link data from R:Base databases to spatial "objects". These objects can be points, lines, polylines (curved lines which may bend in many directions) and polygons (closed polylines which define a region or area). The objects are drawn in AutoCAD which is an industry standard drawing program which uses simple commands (ie. "LINE", "CIRCLE", "ARC", "ELLIPSE", "MOVE", "COPY", "CHANGE", etc). AutoCAD has the capability of importing/exporting objects to and from many other GIS systems (including the Arc/INFO GIS system used by Alaska's Department of Natural Resources). Although these objects are created using AutoCAD they are actually stored in a "spatial database". This storage method reduces the size and number of the files which are stored over the life of a project. The reason for this is simple and the heart of the GIS system--ad hoc queries can be made based on the data stored in the database or its spatial characteristic and these queries are replicable.

This system has been used to store and analyze previous shoreline assessment data. Data on oiling conditions and locations will be collected during the 1993 shoreline assessment survey. Attribute (textual) data will be entered into an R:Base database and linked to shoreline locations. The official state-federal shoreline will be used as a "base-map". Field data will be hand-marked onto 1:10,000 scale computer-generated maps in the field. Laptop computers will be provided onboard the survey vessel(s) in order to enter data

during the survey. This will reduce the chance of data-entry error due to transcription of field notes.

Impact data gathered during the 1994 Survey will be entered into a textual database and linked to spatial line "objects" by segment. A survey team member will digitize oiling impact observations from the 1:10,000 field maps by visually marking the oiling category boundaries on the computerized shoreline using AutoCAD software. This process will reduce production time without introducing significant error. The AutoCAD drawings can be compared with the original field maps by a different survey team member, and all errors corrected. Error-free impact maps will be loaded into the GIS by survey date.

Vector data symbolizing oiling as well as paper maps will be produced upon the completion of the survey. Data sharing among Trustee Agencies will be accomplished using industry-standard AutoCAD drawing exchange format (DXF). Maps will be produced at a variety of scales which show areas surveyed as well as those areas which still contain oil, the characteristics of that oil, and the penetration depth.

93039

Project Title: HERRING BAY EXPERIMENTAL & MONITORING STUDIES

Project ID#: 93039

Project Type: Restoration manipulation and enhancement, and restoration monitoring

Project Leaders: Raymond Highsmith, Michael Stekoll

Lead Agency: Alaska Department of Fish and Game

Project Cost: $478,700 for 1993

Start Date: 3/1/93 **Finish Date:** 9/30/93

Project Term: 4 years

Geographic Area of Project: Herring Bay, Knight Island, Prince William Sound, Alaska

Project Leader Signature:

Project Manager (of Lead Agency)

Name: Dr. Joseph R. Sullivan

Signature:

B. Introduction

Marine Intertidal communities were the largest single category of habitat affected by the Exxon Valdez oil spill (EVOS). Intertidal experiments conducted at Herring Bay, Knight Island, and throughout the EVOS impact area since 1990 clearly show that the oil spill and resultant cleanup activities caused serious damage to intertidal algal and invertebrate populations, especially the middle to upper intertidal zones. The dominant organism in this community is the seaweed *Fucus gardneri. Fucus* makes up 90% of the algal biomass in the intertidal region. Because of its abundance, this alga serves as habitat and food for a variety of invertebrates. These invertebrates serve as an important food source for marine mammals, birds, and fishes. Mammals may also use *Fucus* as a food source. They may consume the *Fucus* directly (deer) or while foraging for invertebrates abundant in the beds (otters and bears). The Herring Bay experiments are designed to examine the impact of oil on relationships between and among intertidal invertebrates and plants, and to provide detailed monitoring of the recovery of intertidal communities over the long term.

Studies to date suggest that plants and animals living in the upper intertidal zone suffered the most extensive damage and recovered least. In 1991, some species were still declining in abundance. *Fucus* was severely damaged by the oil spill and subsequent cleanup efforts. In some areas, entire *Fucus* beds were decimated by the combined effects of oil and cleanup efforts. Thus, many beaches were virtually without *Fucus*. Natural recovery of *Fucus* beds has been slow, especially in the upper intertidal. It may take as much as to 10 years for *Fucus* to fully recover by natural means.

Grazers such as limpets were reduced by the spill and cleanup. They have not recovered, probably due to lack of food and shelter normally provided by the algae. Barnacles have recruited on oiled surfaces, but their initial settlement appears retarded. Our studies show poor subsequent survival of barnacles on oiled tiles. Our data suggest some recovery in the middle to lower intertidal. But recruitment is not consistent between locations and years. The Alaskan intertidal community appears recruitment limited, in contrast to space limitations reported in other areas.

This project will identify major limitations to settlement, recruitment, and growth of *Fucus* and of invertebrates such as barnacles, mussels, and limpets. This will be accomplished by providing controlled, long-term natural recovery monitoring of intertidal communities such that natural variability can be differentiated from oil and cleanup effects. We will also evaluate various methods for *Fucus* restoration by enhancing settlement and recruitment using biodegradable fabric.

C. Project Description

Resources

The resource targeted for this study is the intertidal community within the EVOS affected area. Herring Bay will be used as an experimental site.

Objectives

a. Quantify recruitment rates, survival, and population dynamics of barnacles and other invertebrate species, such as mussels, limpets, and littorines. Oiled sites, oiled and cleaned, unoiled, and matched oiled and unoiled sites will be studied. In addition, comparisons of recruitment and growth rates relative to water motion are to be made to determine if oil tended to be delivered to more productive sites.

b. Determine the recovery rate of important community members which depend upon other species that were reduced or eliminated by the spill, i.e. second-order impacts, as well as the recovery rates of species with poor dispersal capabilities, e.g., the predator *Nucella.*

c. Quantify the structure and population dynamics of *Fucus* and algal community structure in oiled and control sites. Recovery rates will be projected and monitored, especially in the upper intertidal zone areas denuded by the oil spill and/or cleanup activities.

d. Develop techniques for restoring *Fucus* by reducing heat and desiccation stress using biodegradable substrata. The feasibility of inoculating such substrates with *Fucus* embryos as a way of reseeding high intertidal habitat will be tested.

Methods

To fulfill objectives a, b, and c above, population dynamics of *Fucus*, sessile invertebrates, and grazers will continue to be quantified in established quadrats at six pairs of oiled and unoiled sheltered rocky and coarse textured sites. Organisms are to be counted within six 20 x 50 cm permanently established quadrats in each of the first three meters of vertical drop below mean high water. The quadrats are to be visited twice during the summer. The number of *Fucus* plants will be counted and size frequency determined. Reproductive status and condition of the plants will also be recorded. Limpets, mussels, and *Littorina sitkana* will be counted also. Subsamples of each organism will be measured for size.

To fulfill objective a, mussel recruitment (size frequency distribution) will be determined within the mussel band on matched pairs of sites. To determine differences in growth rates related to the amount of water circulation near oiled

and control sites, individual mussels will be tagged and measured at the beginning and end of the field season.

Recruitment of algae and invertebrates on tarred, cleaned, and control substrata (settlement plates and rock substrates) will be determined with and without the presence of grazers. Grazers will be excluded from plots using fences constructed around the rock or tiles and attached with marine epoxy. Barnacle population recruitment studies will be replicated at three tidal heights within the first two meters of vertical drop. Barnacle spat and adult barnacles will be counted each field visit to determine the survival rate of recruits over time. Relative current strength will be determined by measuring the dissolution rate of calcium sulphate (as plaster of paris) near each site. Comparisons will be made to recruitment and survival rates.

To fulfill objective c, above, growth rates of different sized, tagged *Fucus* plants will be determined on oiled and control sites. The same plants that were used in 1991-1992 will be measured. There were two site pairs with three size classes of plants (2-4.5 cm, 5-9.5 cm, and $\geq$ 10 cm) at three tidal levels. Plants are to be measured twice throughout the summer. For each plant, total length, reproductive status of the greatest number of receptacles, number of receptacles, and maximum width of the plant will be recorded.

Studies will be continued on *Fucus* egg dispersal, survival, and recruitment at oiled and unoiled sites. A single fertile plant, or group of plants, will be moved to an area with no other fertile plants within 20 meters. Etched plexiglass plates are to be placed next to the holdfast and at 10, 20, 40, 80, 120, and 200 cm from the holdfast running directly right, left, up, and down from the source plant. By counting the number of eggs that settle onto each plate, the direction of egg dispersal and dispersal distance can be determined. This experiment is to be done on beaches of various slopes. Also, plexiglass plates will be used to determine the natural settlement of *Fucus* eggs onto oiled and control sites. Plates are to be placed at three levels at four pairs of sheltered rocky sites. The experiment will run for three consecutive days at each site pair. The number of eggs settling on each plate will be counted after each day. Direction and distance to the nearest fertile *Fucus* plant will also be recorded for each plate. The experiment is to be repeated twice.

Survival and growth rates of *Fucus* germlings will be determined as a continuation of an experiment deployed in 1992. In the laboratory, *Fucus* eggs were seeded on handmade ceramic plates that had six horizontal grooves. Before deployment, the density of the germlings was estimated for each plate. At each of three pairs of oiled and control sites, four plates were placed at two tidal heights along a randomly selected transect. Survival and growth rate of the *Fucus* germlings on the plates is to be monitored during the summer of 1993. Additional plates were placed at each site with Vexar mesh surrounding them to exclude grazers.

For the *Fucus* restoration study (objective d, above) biodegradable erosion-control fabric seeded with *Fucus* embryos will be used. The potential problem of lack of natural settlement will be avoided by seeding the fabric with *Fucus* embryos. Unseeded strips will be used to test whether embryo seeding is necessary. The cost effectiveness of this procedure for large-scale restoration will be assessed.

Alternatives

The techniques and studies proposed were used during the field seasons of 1990, 1991, and 1992. To maintain consistency in the data over time, similar sampling procedures should be used for future field efforts.

Location

The proposed restoration, monitoring, and experimental studies will be conducted in the Herring Bay, Knight Island area. Intertidal studies were initiated in Herring Bay in May 1990 and have continued through the 1992 field season. Herring Bay was heavily oiled in 1989, and was a central area for cleanup efforts. This bay was chosen for its oiling history and proximity to nonoiled control sites. A map of the Herring Bay region is enclosed for this study.

Benefits

A major goal of restoration is to ensure that injured resources are restored to their pre-spill baseline conditions. Many plant and animal species were damaged directly by the fresh crude oil or the cleanup activities. Previous work in Herring Bay showed that some populations continued to decrease in 1991 and 1992. This suggests continuing expression of the original impact or additional damage due to residual oil. Studies on the effects of the oil spill on intertidal community structure and recovery dynamics have been conducted in Herring Bay since 1990. A long-term monitoring commitment will provide several benefits including (1) an understanding of the year-to-year variables that affect intertidal community structure, (2) an understanding of long-term consequences of an oil spill, and (3) establish baseline data and an understanding of complex community structuring mechanisms at monitoring locations strategically located within Prince William Sound, should there be future perturbation. In addition, the *Fucus* experiments outlined above should provide enough information to make recommendations on which areas should be artificially restored and whether this is a cost effective method of large-scale restoration.

Technical Support

Principal investigators from several research facilities will cooperate to provide expertise on the different aspects of the study. A project manager will oversee all logistical and personnel aspects of the project and insure that the proper specialist is available for each aspect of the project. The manager will charter a vessel or

research platform for the field studies and arrange for transportation of field personnel with local air taxi operators. Mobilization and demobilization will be managed through the Seward Marine Center in Seward, Alaska. The project manager, along with the principal investigators and four technicians, will participate in field and laboratory activities and data analyses. After the field season, sample and data analysis will be done at the School of Fisheries and Ocean Sciences (SFOS), University of Alaska Fairbanks (UAF); the Juneau Center, School of Fisheries and Ocean Sciences, University of Alaska Southeast; and through Coastal Resources Associates (CRA), Vista, California, using available computers and laboratory equipment.

Contracts

The primary contract for this project is for use of a research vessel able to support the field work in Herring Bay. This vessel must meet all University safety requirements and be of sufficient size and configuration to meet the needs of the science specified above. Bid specifications will be drawn up and request for proposals sent to prospective bidders. Proposals will be handled according to standard University procurement procedures. After inspecting the top ranking vessels, a final selection will be made. The contract will be awarded to the bidder with the lowest cost that has met all of the proposal requirements. After terms are accepted, a contract will be initiated.
A similar contract will be established for air taxi support. The University will send out a request for proposals for air taxi support between Seward and Herring Bay, Knight Island. This support is needed for transporting principal investigators and project personnel to and from the work sites.

A contract will be issued to CRA. CRA has been involved with the Herring Bay study from its inception in 1990. To maintain consistency with the data collection, experiment modifications, analyses, and report writing, it is necessary to continue the existing contract with CRA.

Mitigation Measures

No mitigation measures are required for this project.

Schedules and Planning

During the summer of 1993 four trips to Herring Bay are planned. They will be of nine to fourteen days duration. The first trip will take place in May and be slightly longer than the remaining three. Subsequent trips will occur each following month during the lowest tide series. The extra time in the first trip will be used to set up and maintain established experiments. The bulk of the remaining trips will be used to monitor experiments.

RESEARCH PROPOSAL

TO: Trustees Council
c/o Alaska Department of Fish and Game
333 Raspberry Rd.
Anchorage, AK 99502

FROM: Institute of Marine Science
School of Fisheries & Ocean Sciences
University of Alaska Fairbanks
Fairbanks, Alaska 99775-1080

TITLE: Herring Bay Experimental and Monitoring Studies

PRINCIPAL INVESTIGATOR: Raymond C. Highsmith
Professor
SS# 479-44-6750

NEW/CONTINUING: New

PROPOSED STARTING DATE: 1 March 1993

PROPOSED DURATION: 7 months

AMOUNT REQUESTED: $ 478,700

R. C. Highsmith 12/10/93
Raymond C. Highsmith Date
Principal Investigator
(907) 474-7836

A. Tyler 10 Feb 93
A. V. Tyler, Associate Dean Date
School of Fisheries & Ocean Sciences
(907) 474-7532

John J. Goering 12/11/93
John J. Goering Date
Associate Director, Institute of Marine Science
(907) 474-7895

12/12/93
Charles E. Graham, Director Date
Office of Sponsored Programs
(907) 474-7937

Joan Osterkamp 12-11-93
Joan Osterkamp Date
Executive Officer
School of Fisheries & Ocean Sciences
(907) 474-7824

February 1993

A tentative schedule of working days in Herring Bay is:

Trip #1:	May 30-June 11
Trip #2:	June 30-July 11
Trip #3:	July 30-Aug 9
Trip #4:	Aug 29-Sept 6

Activities scheduled and budgeted within this budget period:

March-April 1993:	Obtain boat, air taxi charter, CRA contract.
Mar-May 1993:	Finalize Standard Operating Procedures for field experiments.
March-May 1993:	Purchase/prepare field equipment.
May-Sept. 1993:	Field sampling dates as shown above.
June-Sept. 1993:	Sample analysis.
Sept.-Oct. 1993:	Data analysis and interpretation.

Activities scheduled and budgeted within this budget period:

Oct.-Dec. 1993:	Report writing.
Dec. 10, 1993:	Submit draft report to and peer reviewers (estimate two months for reviews).

45 Days after draft report returned by peer reviewers, a final report will be submitted to ADF&G.

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

1. Dr. Ray Highsmith (Coordinator, Principal Investigator)

   Responsibilities will include general coordination of Principal Investigators and all project personnel, interpretation and synthesis of data, and report writing.

2. Dr. Michael Stekoll (Co-Principal Investigator)

   Responsibilities will include experimental design, interpretation and synthesis

of data, and report writing.

3. Dr. Peter van Tamelen (Research Associate)

   Responsibilities include experimental design, supervising of field algal studies, interpretation and synthesis of data, and report writing.

4. Andy Hooten (Chief Scientist)

   Responsibilities include experimental design, supervising of field invertebrate studies, interpretation and synthesis of data, and report writing.

5. Dr. Larry Deysher (Restoration Investigator)

   Responsibilities will include experimental design, interpretation and synthesis of algal data, and report writing.

6. David Doudna (Project Manager)

   Responsibilities include obtaining charters and subcontracts, administering the budget, and project logistics.

7. Technicians

   Technicians will conduct field experiments and monitoring, and sample and data analyses for report preparation.

E. Environmental Compliance/Permit/Coordination Status

This project is categorically excluded under the National Environmental Policy Act (NEPA) regulations. State scientific collection permits will be obtained from the Alaska Department of Fish and Game () before beginning the filed season.

F. Performance Monitoring

The Coordinating Principal Investigator, Ray Highsmith, will be responsible for the completion of the project. He will oversee the design of experiments, data analysis and the preparation of the final report. The additional co-Principal Investigator, Michael Stekoll, along with Peter van Tamelen, Larry Deysher and Andy Hooten, will be responsible for drafting standard operating procedures, setting up and monitoring experiments, analyzing data, and writing reports. The Project Manager, David Doudna, will be responsible for coordinating research efforts, budget management, administration of contracts, and management and timing of important events and tasks. The technicians will conduct field experiments and help carry out restoration and monitoring techniques. They will also conduct sample and data analyses for report preparation.

Alternate crew leaders are available for field experiments in the absence of the Chief Scientist or the Research Associate. These alternates acted as crew leaders in Herring Bay in the past. They supervised field work over the past three summers on a corresponding oil spill project. Ray Highsmith and Andy Hooten, worked together on invertebrate ecology in Herring Bay since 1990. In the absence of one investigator, the other would complete the data analysis and report writing. Mike Stekoll, Peter van Tamelen and Lawrence Deysher have worked on algal experiments and monitoring in Herring Bay since 1990. In the absence of one of these investigators, the other two could conduct the work necessary for most of the experiments.

Quality control for counting organisms will occur through multiple counts. Personnel are experienced in identifying algae and invertebrates in the field. At the beginning of the field season, the field supervisor will spot check the accuracy of each technician for identification and counting procedures. Spot checks will occur throughout the summer. Data base programs exist to enter the data that is collected for experiments ongoing since 1990. Similar data bases will be created for new experiments. Statistical methods used to analyze the data from 1990, 1991, and 1992 will be continued. These methods were reviewed by WEST, Inc., a statistical consulting firm subcontracted during several oil spill studies, including the 1990-1992 Herring Bay project.

Data analysis procedures will retain as much continuity as possible from interpretations of field data collected in 1990, 1991, and 1992. This will make it possible to directly compare sites over time.

After each field trip, data analysis will take place. Following the last field trip, all efforts will be toward the completion of data analysis, integration, and preparation of a report to be submitted as a draft in December 1993. A final report will be submitted within 45 days of receiving comments from the peer reviewers.

The final report will include complete documentation of the methods used for sampling and analyses of the data, documentation of the location of sites, including maps, and summary findings for each of the specific study components. Relevant background information, discussions on methodologies, techniques, equipment, analyses, and interpretation of results will be included. The following general format will be followed: Executive Summary, Introduction and Background, Methods, Results, Discussion, Conclusions, References, Appendices.

G. Personnel Qualifications

1. Dr. Raymond Highsmith

Dr. Ray Highsmith was the Coordinator and Principal Investigator of two Exxon Valdez Oil Spill projects which started in 1989; the Coastal Habitat Injury

Assessment project and the Herring Bay studies. His background includes ongoing research on the study of recruitment and population biology in the intertidal zone. He is familiar with the effects of oil on intertidal invertebrates throughout the area. Dr. Highsmith published many papers on the ecology of intertidal and benthic communities in Alaska. He is currently a Professor at the School of Fisheries and Ocean Sciences at the University of Alaska Fairbanks, and Director of the West Coast National Undersea Research Center.

2. Dr. Michael Stekoll

Dr. Stekoll was the principal investigator of two Exxon Valdez Oil Spill projects starting in 1989, including the Herring Bay studies. He was present in Herring Bay during the 1989-1992 field seasons and is familiar with all study sites. He is familiar with the effects of the oil spill on intertidal algae throughout the area. He also conducted many projects on the biology and ecology of *Fucus* and other seaweeds in Alaska. Dr. Stekoll is currently a Professor at the University of Alaska Southeast with a joint appointment in the School of Fisheries and Ocean Sciences at the University of Alaska Fairbanks.

3. Andy Hooten

Andy Hooten has worked in Herring Bay since 1990 on intertidal invertebrate damage assessment and experiments for monitoring recovery of damaged resources. He supervised the design of experiments during field studies and analyzed and integrated data for draft and final reports to government agencies during the Herring Bay research. He has spent a total of 12 months in Herring Bay and is very familiar with the established study sites and the natural history of the area. His experience at the study sites will help insure continuity between the study proposed for 1993 and the studies conducted in 1990-1992.

4. Dr. Peter van Tamelen

Dr. van Tamelen has worked in Herring Bay since 1990 on some of the projects described here. He has extensive experience in marine intertidal ecology including studies on plant-herbivore interactions, succession, algal recruitment, and effects of physical factors on biological communities. Dr. van Tamelen spent a total of 12 months in Herring Bay and is very familiar with the established study sites and the natural history of the area. This familiarity makes him uniquely suited to continue this research. He has published scientific papers in refereed journals with many papers in the publication process. Dr. van Tamelen is currently employed as a research associate at the University of Alaska Southeast.

5. Dr. Lawrence Deysher

Larry Deysher was an investigator for two EVOS projects starting in 1989, including the Herring Bay studies. He was involved in Phase I (site-selection) and

Phase II (damage assessment) of the Coastal Habitat Injury Assessment project. Larry is a senior scientist at CRA. His specialties are general intertidal ecology, algal ecology and taxonomy, and ecological surveys. He was present in Herring Bay during the 1990, 1991, and 1992 field seasons and is familiar with the established study sites. He conducted a pilot study on the use of biodegradable fabrics for restoration of *Fucus*.

6. David Doudna

David Doudna has been project manager for the Coastal Habitat Injury Assessment project since 1990. This project covered three regions, Prince William Sound, Cook Inlet-Kenai Peninsula, and Kodiak-Alaska Peninsula. He oversaw all management aspects of the project including logistics and personnel placement. As manager, he staffed three field laboratories for the sorting and taxonomic identification of invertebrates. He also obtained charters for and staffed three charter vessels with field personnel for two 5-month field seasons during the summers of 1990 and 1991, obtained charters for the Herring Bay research platform and vessels during the field seasons of 1990, 1991, and 1992, administered subcontracts for vessels, air charters, freight and shipping of equipment, and consulting firms, and oversaw the budgets and preparation of proposals and reports.

The following is a list of the contracts on which all or some of the above-mentioned principal investigators collaborated:

Trustees (Oil Spill) via U.S. Forest Service. Comprehensive Assessment of Injury to Coastal Habitats: Phase II. 3/1/92-6/30/93, $2.3 million (R. Highsmith, M. Stekoll, W. Barber, L. McDonald, D. Strickland, L. Deysher), Contact person Dave Gibbons (907) 586-8784.

Trustees (Oil Spill) via Alaska Department of Fish and Game. Herring Bay Restoration/Monitoring Studies. $451,000 (R. Highsmith, M. Stekoll, P. van Tamelen, A. Hooten, L. Deysher), Contact person Dean Hughes (907) 267-2207.

Trustees (Oil Spill) via U.S. Forest Service. Comprehensive Assessment of Injury to Coastal Habitats: Phase II. 3/1/91-2/28/92, $5.1 million (R. Highsmith, M. Stekoll. W. Barber, L. McDonald, D. Strickland), Contact person David Gibbons (907) 586-8784.

Trustees (Restoration) via U.S. Forest Service. Herring Bay Restoration Studies. 3/1/91-2/28/92, $245,000 (R. Highsmith, M. Stekoll, L. McDonald, D. Strickland, A. Hooten), Contact person David Gibbons (907) 586-8784.

Trustees (Oil Spill) via U.S. Forest Service. Comprehensive Assessment of Injury to Coastal Habitats: Phase II. 10/1/90-2/28/91, $1.3 million (R. Highsmith, M. Stekoll, W. Barber, L. McDonald, D. Strickland), Contact person David Gibbons (907) 586-8784.

Trustees (Oil Spill) via U.S. Forest Service. Comprehensive Assessment of Injury to Coastal Habitats: Phase II. 3/1/90-2/28/91, $7.6 million (R.Highsmith, M. Stekoll, L. McDonald, D. Strickland), Contact person David Gibbons (907) 586-8784.

Trustees (Oil Spill) via U.S. Forest Service/State of Alaska. Conduct a damage assessment/restoration study of the shallow subtidal environment of Prince William Sound relative to the Exxon Valdez oil spill. 7/89-present, $753,445 (USFS, 1989-1990), $486,800 (State of Alaska, 1990-1991), (S. Jewett, M. Stekoll, L. McDonald), Contact person David Gibbons-USFS (907) 586-8784; Mark Fraker-ADF&G((907) 267-2136.

Alaska Department of Environmental Conservation. Effects of oil slicks on herring development. 4/1/84 - 8/1/84, $6,710 (M. Stekoll).

Environmental Protection Agency. Long term effects of petroleum on nearshore marine organisms. 1/1/76 - 6/30/78. (D. Shaw, M. Stekoll, D. McIntosh).

H. Budget

Personnel	$ 7.5
Travel	0.0
Contractual	478.7
Commodities	0.0
Equipment	0.0
Sub-total	$486.2
General Administration	21.3
Total	$507.5

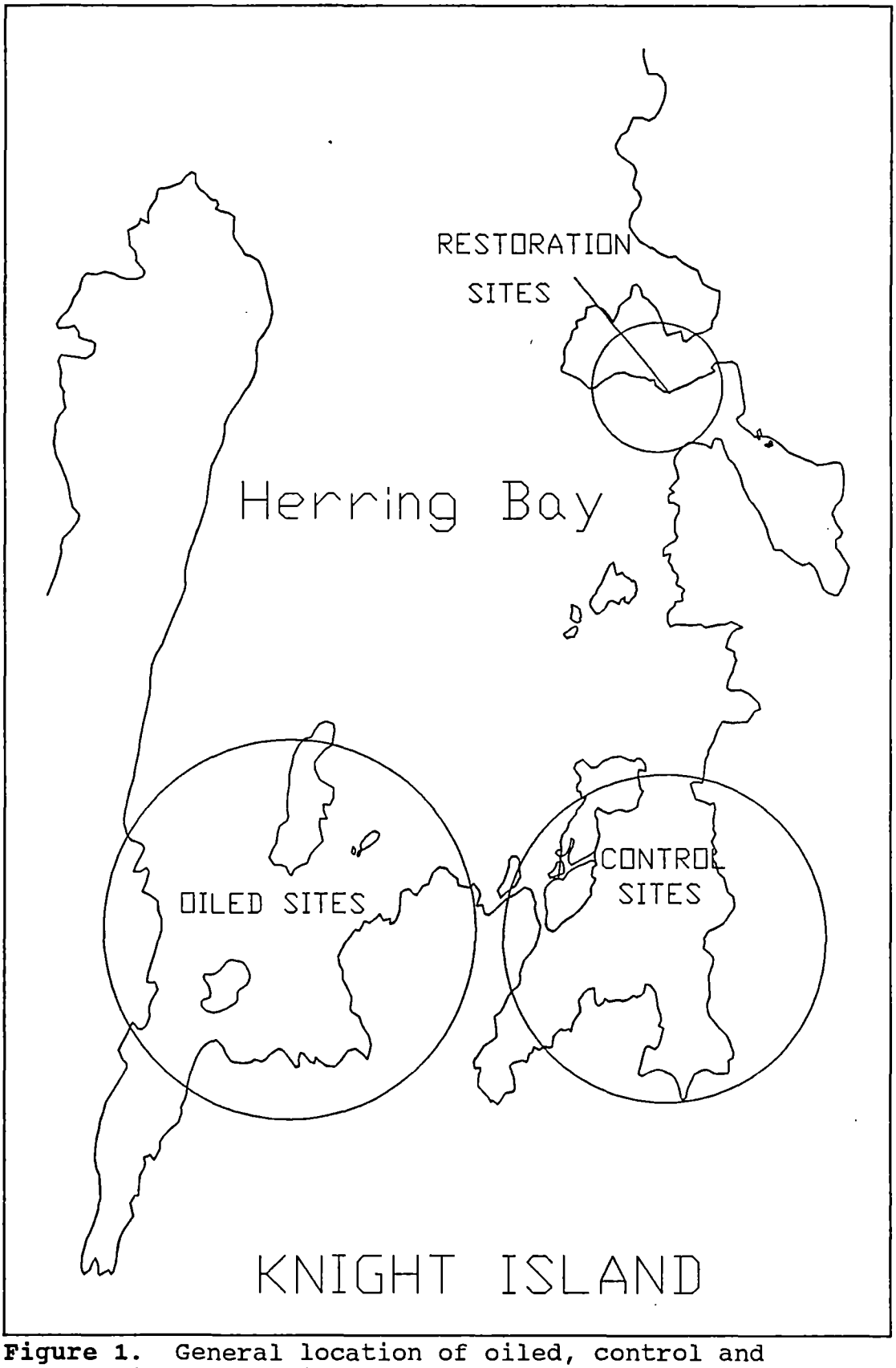

Figure 1. General location of oiled, control and restoration study sites in Herring Bay.

Project Description: Restoration, monitoring and experimental studies will be conducted to quantify recruitment rates, survivorship and population dynamics of intertidal plants and associated invertebrate animals. Recovery rates of important species will be determined for species reduced or eliminated from oiled and cleaned beaches. Techniques for restoring *Fucus*, the principal intertidal alga impacted by the spill and clean-up, will be developed.

Budget Category	Approved 1-Oct-92 28-Feb-93	Proposed* 1-Mar-93 30-Sep-93	Total FY 93	** FY 94	FY 95	FY 96	FY 97	Sum FY 98 & Beyond
Personnel	$5.0	$7.5	$12.5					
Travel	$0.0	$0.0	$0.0					
Contractual	$102.1	$478.7	$580.8					
Commodities	$0.0	$0.0	$0.0					
Equipment	$0.0	$0.0	$0.0					
Capital Outlay	$0.0	$0.0	$0.0					
Sub-total	$107.1	$486.2	$593.3	$0.0	$0.0	$0.0	$0.0	$0.0
General Administration	$2.8	$21.3	$24.1					
Project Total	$109.9	$507.5	$617.4	$0.0	$0.0	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)	0.1	0.1	0.2					

Budget Year Proposed Personnel:

Position	Months Budgeted	Cost
Program Manager	1.0	$7.5

Comment

* FY 93 is a transition year from the previously used oil fiscal year to the federal fiscal year. This new project also includes proposed funding for January and February, 1993.

** If not funded in FY 93, $180.0K is needed for analyses of data and report preparation.

17-Jul-92

1993

Project Number: 93039
Project Title: Herring Bay Experimental and Monitoring Studies
Agency: AK Dept. of Fish & Game

FORM 2A PROJECT DETAIL

		Proposed
Travel:	None	
Contractual:	14-RT's Fairbanks to Seward ($1.5) 10-RT's Juneau to Seward ($4.4) 2-RT's Juneau to Anchorage/Fairbanks ($2.0) 4-RT's Fairbanks to Anchorage/Juneau ($4.0) 1-RT Washington D. C. to Fairbanks ($4.0) 1 RT Juneau to Coastal Resources Associates in California ($1.5) Scientific meetings ($2.9) Vessel Charter ($85.0) Aircraft charter ($7.7) Freight/Shipping ($1.0) Sub Contract with Coastal Resource Field supplies, lab supplies, data analysis supplies, office supplies, warehouse, phone, fax, xerox, data management, equipment maintenance ($189.6) Data Logger and Sensors ($9.0) Field computer ($3.5) Fuel, supplies, equipment, maintenance, repair ($49.9)	$478.7
Commodities:	None	
Equipment:	None	

Project Number: 93039
Project Title: Herring Bay Experimental and Monitoring Studies
Agency: AK Dept. of Fish & Game

FORM 2B
PROJECT
DETAIL

Herring Bay Physical Oceanographic Survey

Mark Johnson, Institute of Marine Science, University of Alaska

A physical oceanographic survey of Herring Bay, Alaska and the adjacent passage is proposed. The three dimensional flow field will be measured using an Acoustic Doppler Current Profiler (ADCP). We will determine the current structure over a complete tidal cycle to provide a description of the flow field during both the rising and falling tide. This survey will provide a snapshot of the currents during September 1993, yielding information useful to understanding the region's general circulation as well as how the tidal cycle influences Herring Bay. Transects across nearby Knight Island Passage will determine both volume transport through the Passage and the vertical and horizontal structure of currents adjacent to Herring Bay.

The ADCP uses information from acoustic pulses reflected by particles in the water column back to the ADCP. Water motion causes the acoustic reflections to be doppler shifted in frequency, and this shift is used to compute the horizontal and vertical current velocities. Mark Johnson has used the ADCP successfully in water up to 400m in the Arctic with excellent results. A direct comparison between measured currents from a suspended current meter and the ADCP confirms that the ADCP accurately measures currents with an error of 1 cm s^{-1}.

In the Arctic, the ADCP was suspended at the sea surface approximately 10m portside from the ship using its crane. In Herring Bay, we propose to use a mounting bracket attached to the port or starboard I-beams mounted near the stern overdeck of the ship so that the ADCP's transducers are approximately 1m below the surface of the water. The mounting bracket will be custom built to fit the ship and ADCP. A preliminary design is being drafted. Instrument roll and pitch will be the same for the ship and ADCP, and the 130 ft ship used for this work will damp out high frequency roll and pitch. Except in extreme conditions, roll and pitch are accounted for by the ADCP software when determining the velocity field.

The survey will require five days of ship time including transit time. Days one and two will be used for transit to the site and to install the ADCP into its mounting bracket, mount the bracket to the ship, and test the ADCP. The remaining three days will be used to survey the northern portion of Knight Island Passage and Herring Bay and return transit. Three nearly east-west lines across the Passage will give us quantitative information on the transport and velocity field from near surface to 85% of water depth. (The geometry

of acoustic pulses that reflect off the bottom and return to the ADCP can confuse the ADCP software's determination of currents within 15% of the bottom.) The three transects are about 30nm in length. At 3 knots we should be able to complete the Knight Island Passage survey in one day. The relatively slow ship speed is required to maximize the spatial resolution of measured currents and minimize missing data due to air bubbles generated by the ship's wake that block the acoustic pulses.

Inside Herring Bay, six transects across the Bay are proposed, with the survey beginning in the north. Additionally, a transect around the perimeter of the Bay will determine the flow there and give a complete picture of the horizontal and vertical velocities. We expect to complete this pattern twice with the sampling plan adjusted so that the temporal distribution of the data cover both a flood and ebb tide.

Budget Discussion

Mark Johnson requests two weeks of time. One week will be spent at sea and traveling between Fairbanks and the study site. Another week will be spent supervising a graduate student for one semester to calibrate and process the ADCP data. These data are not easy to work with, and this time is a bare minimum for Johnson and graduate student. We will use the ship's crew to help in handling the ADCP. Smithhisler is a marine technician who has worked extensively with Johnson in the Arctic. His services are required to handle shipping of the ADCP from the east coast (return port following work in the Arctic) to Prince William Sound and to do a preliminary post-cruise ADCP checkout and calibration. Travel funds are needed to get Johnson to and from the ship using commercial and charter air travel. Services include the vessel charter and post-cruise ADCP calibration. Supplies include spare parts and the mounting bracket for the ADCP.

Budget for Physical Oceanography Survey
of Herring Bay, Alaska

SALARIES AND BENEFITS			
Johnson, M.	0.5 Mos.		
Graduate Student	6 Mos.		
Smithhisler, J.	1 Wk.		
TOTAL SALARIES AND BENEFITS			$11,986
TRAVEL			
R/T Fairbanks-Anchorage		$420	
Per diem (2 days)		$220	
Anchorage-PWS (charter airfare)		$720	
TOTAL TRAVEL			$1,360
SERVICES			
Communications		$280	
Computer Storage		$390	
Shipping (ADCP)		$865	
ADCP Calibration		$1,970	
Vessel Charter-PWS (5 days at $1500/day)		$7,500	
TOTAL SERVICES			$11,005
SUPPLIES			
ADCP Spare Parts		$1,970	
ADCP Mounting Bracket		$2,165	
TOTAL SUPPLIES			$4,135
STUDENT TUITION - 1 semester			$2,300
TOTAL DIRECT COSTS			$30,787
INDIRECT COSTS (20% MTDC)			$6,158
TOTAL FUNDING REQUIRED			$36,945

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Photo-Identification Studies of Killer Whales
1993
Prince William Sound

Scope of Work

On 24 March 1989, the supertanker Exxon Valdez went aground on Bligh Reef spilling approximately 11.2 million gallons of Alaskan crude oil into the waters of Prince William Sound, Alaska. As a result, much concern was raised about the possible impact of oil on wildlife. Since 1984, research on killer whale populations within Prince William Sound have included photo-identification studies to assess the number of whales occurring in the area and habitat use patterns. Concern was raised that the oil spill may effect killer whale abundance, distribution, natality and mortality rates, continuity of habitat useage or social behavior/pod integrity. Changes in the life history or ecology of killer whales as a result of the oil spill could effect whale survival in the Sound.

One of the Prince William Sound pods, AB pod, had 36 whales when last sighted before the spill in September 1988. When sighted on March 31, 1989, seven days after the spill, seven individuals were missing. Six additional whales were missing from AB pod in 1990. Assuming that whales missing for two consecutive years are dead, the mortality rates for AB pod were 19.4% in 1988-89 and 20.7% in 1990-91. An additional whale was missing in 1991, but a calf was also born into the pod this year. No whales were reported missing in 1992 and two births were reported.

The purpose of this contract is to obtain photographs of

individual killer whales, with an emphasis on AB pod, occurring throughout the Prince William Sound area from early July 1993 to approximately 7 September 1993. Photographs collected in 1993 will be compared to the photographic database available for the years 1989 to 1991 to determine if changes have occurred in whale abundance, distribution, mortality or natality rates. The 1993 study is a continuation of the damage assessment work conducted in 1989, 1990, and 1991. NMFS will supply necessary research documentation for the years 1989 through 1991 so that similar methodology will be employed during the 1993 season.

The contractor will be required to (under Line Item 1): 1) Carry out research activities to obtain photographs of individual killer whales (left side of dorsal fin and saddle patch) in Prince William Sound between early July 1993 and approximately 7 September 1993. The contractor will provide trained, competent personnel, vessels, and all logistic and scientific equipment to conduct all necessary field work. Contractor arranges total support of field team throughout the field season.

Personnel can be stationed at a shore-based camp, a live-aboard vessel, a support barge, or located at local villages. If shore-based camps are established, it is important to receive necessary permits for camping operations. The research platform (a highly-maneuverable vessel) will be staffed by at least three biologists (two photographers and one driver) which are trained in accepted photo-identification techniques. The National Marine Mammal Laboratory will supply one researcher for the entire

field season to act as a photographer. For consistency in data collection, key personnel should remain in the field throughout the field season.

Field personnel are required (weather permitting) to conduct daily surveys in search of killer whales. Contractor must ensure that adequate time and effort (12 hours per day, 6 days per week) are spent throughout the southwest corner of Prince William Sound to properly assess whale presence or absence. Prior to field investigations, contractor will provide a search sampling scheme to the COTR for discussion and overall approval. Daily effort logs, specifying routes travelled and amount of time spent in travelling versus collecting photographs, must be kept. Examples of previous efforts logs can be provided. Once whales are encountered, they should be followed until such time that the researcher is confident that a high quality photograph of the animal(s) is obtained. A record of all photographs collected should contain pertinent information to include date, time, location, number of animals in pod or area. If more than one group or individuals are encountered, contractor should provide rationale for choosing one group over the other. Information should also be provided on the number of animals not photographed in the session. An assessment of general behavior should be given (e.g, travelling, feeding, resting). Begin and end times and locations of photographic effort should be noted for each encounter. If possible, prey items (e.g., fish scales or fish parts found floating on the surface of the water where whales are apparently feeding) or whale fecal material should be collected.

Sightings reported from the sighting's network system developed in the Prince William Sound area should be responded to by members of the research team. Every attempt should be made to respond to these reports to verify whale occurrence, identification and collect photographs of whales.

2) Contractor is required to work cooperatively with NMML in setting up a Sightings Network System in Prince William Sound. The network, which would include Alaska State Ferry System, various federal, state, and private aircraft and vessels working the area, would collect opportunistic sightings of cetaceans. These sightings would be reported to the research via vessel/aircraft radios at scheduled times. The biologists would make every effort to search the area in question for whales.

3) All dead and stranded marine mammals observed in the Prince William Sound area should be reported to the COTR who will make necessary arrangements for proper collections of specimens and disposition of same. In the event that difficulties arise in the collection of samples by designated agents, contractor may be requested to collect necessary samples under established protocol.

4) Contractor is required to communicate bi-monthly with the COTR to brief them on the status of research conducted to date in Prince William Sound.

5) Contractor will be required to submit all exposed film to the National Marine Mammal Laboratory for development, processing and analyses. U.S. government mailers can be supplied. Each film canister must be labelled properly (examples will be provided).

The National Marine Mammal Laboratory will be responsible for contracting an independent researcher, highly skilled in killer whale photo-identification techniques, to complete this analyses task. The contractor performing the analyses of these data will work closely with NMML personnel. All analyses and comparisons of photographs will be completed at the National Marine Mammal Laboratory where previous data are archived. Killer whale photographs collected during the 1993 season will be visually compared to the database/catalogue of previously identified Prince William Sound killer whales, available for the years 1989 to 1991, to determine presence or absence of pods and individuals, possible changes in pod structure and timing in the area. Calves of the year will be noted. All negatives are the property of the National Marine Mammal Laboratory and will be, as in previous years, archived at NMML.

6) Results of these investigations on Prince William Sound killer whales will be added to other information being collected on Alaskan killer whales. Data resulting from this contract and subsequent analysis will be the exclusive property of NMFS and will not be disseminated or published without the permission of the COTR. Depending upon the contribution of the contractor, the contractor may be asked to participate as a coauthor on publications resulting from this work. The contractor will receive recognition in all publications for the work accomplished.

7) The contractor will submit a report summarizing field operations. The field report will contain a detailed account and

record of all field activities.

8) The contractor will also provide all original field data forms to NMML to include a) killer whale encounter forms, and b) daily vessel logs to include tracklines. All data collected during this contract is the property of the U.S. Government.

1993 BUDGET

Salaries	
Two field biologists at 1,500 x 2 months	6,000.00
One field biologist supplied by NOAA	N/C
Principal Investigator 3,000/month x 2 months	6,000.00
Subtotal	12,000.00
Travel	5,000.00
Vessel charter and fuel	30,000.00
Food and Lodging	15,000.00
Scientific equipment to include:	
cameras, film, radios, and binoculars.	8,000.00
Business Costs/telephone expenses	2,000.00
TOTAL COST	$ 72,000.00

JUSTIFICATION FOR UNUSUAL AND COMPELLING URGENCY

Fourth year studies related to the Exxon Valdez oil spill dictate prompt and complete assessment of the nature of the impact on cetaceans. The delay of this research could severely hamper the Government's attempt to assess oil impact on killer whales since movements of different whale pods and individuals occur throughout the season in Prince William Sound. The contractor must include personnel with prior photo-identification research experience on killer whales which is of extreme importance to the overall success of the work. A potential list of bidders that have the required expertise is provided for this reason.

LIST OF POTENTIAL BIDDERS

1. Mr. Craig Matkin
   North Gulf Oceanic Society
   P. O. Box 15244
   Homer, Alaska 99603

2. Mr. Kenneth C. Balcomb/Kelly Balcomb-Bartok
   Center for Whale Research
   1359 Smuggler's Cove Road
   Friday Harbor, Washington 98250

3. Dr. John Hall
   Hubbs Research Institute
   1700 South Shores Road
   San Diego, California 92107

4. Mr. John Calambokidis
   Cascadia Research Collective
   Waterstreet Bldg., Suite 201
   218 1/2 W. Fourth
   Olympia, Washington 98501

5. Mr. Dan McSweeney
   P. O. Box 139
   Holualoa, Hawaii 96725

6. Dr. Gary Thomas
   Prince William Sound Science Center
   P. O. Box 705
   Cordova, Alaska 99574-0705

7. Dr. David Bain
   4680 Limestone Point Road
   Friday Harbor, Washington 98250

8. Mr. Tom Fink
   Chenega Corporation
   907/333-7451

9. Mr. Dave Jensen
   Camp David Barge
   408/426-3427

93043

EXXON VALDEZ DRAFT DETAILED PROJECT DESCRIPTION

Project Title: Sea Otter Population Demographics and Habitat Use in Areas Affected by the *Exxon Valdez* Oil Spill

Project Number: 93043

Project Type: Restoration Monitoring/Restoration Habitat Protection

Lead Agency: U.S. Department of the Interior, Fish and Wildlife Service

Cooperating Agencies: None

Project Cost: FY93 - $264.3, FY94 - $133.9

Start Date: April 1, 1993 **Finish Date:** March 31, 1994

Project Location: Field work will be conducted in Prince William Sound, Alaska and data will be analyzed at the U.S. Fish and Wildlife Service office in Anchorage, Alaska

Project Leader: Brenda E. Ballachey, Wildlife Biologist Date: April 14, 1993

Project Manager: William K. Seitz for Leslie Holland-Bartels, Supervisory Fish and Wildlife Biologist Date: April 14/93

B. Introduction

Sea otters (*Enhydra lutris*) are a well-known marine mammal species in Alaska. They historically occurred throughout coastal waters of the north Pacific, but as a result of fur harvests in the 18th and 19th centuries, they came close to extinction. Sea otters have since increased in abundance and distribution and presently are found in most coastal areas of southern Alaska. Sea otters prey on a variety of invertebrate species, including mussels, clams, crabs and sea urchins.

Sea otters were severely injured by the *Exxon Valdez* oil spill. Immediate losses associated with the oil spill probably ranged from 3,000 to 5,000 animals (Doroff et al. 1993). Sampling of sediments and sea otter prey items indicates exposure of otters to petroleum hydrocarbons may be continuing (Babcock et al. 1993; Rounds et al. 1993). Preliminary results suggest that this exposure, at a minimum, may be affecting sea otters at an organismic level and, at a maximum, may be affecting survival and therefore recovery of the population. A 1989 post-spill survey in Prince William Sound (PWS) found increased numbers of otters in non-oiled areas and decreased numbers in oiled areas, with an overall decline from pre-spill abundance (Burn 1993). Surveys in 1990 and 1991 show continued low numbers of otters (Burn 1993). The age distribution of dying sea otters (based on recovery of beach-cast carcasses) in oiled areas of PWS in 1990 and 1991 indicated an abnormally high mortality of prime-age sea otters. Overwinter survival of weanling sea otters in oiled areas in 1990-91 was lower than survival of weanlings in non-oiled areas. These studies, together with results from blood and contaminant analyses, suggest that the sea otter population within the spill zone still may be compromised by exposure to oil. The potential for recovery of affected sea otter populations is not known.

We propose to monitor affected populations and evaluate patterns of habitat use in order to guide the development of strategies to aid in the recovery of the sea otter population in PWS in the aftermath of the *Exxon Valdez* oil spill. Specifically, we will (1) apply newly developed survey methodology to obtain more precise estimates of sea otter population abundance and distribution, (2) evaluate mortality patterns through beach surveys to recover sea otter carcasses, (3) model the sea otter population to predict recovery, and (4) analyze patterns of habitat use. Results from this project will enhance our understanding of the demographics of sea otter populations and patterns of habitat use by sea otters in PWS.

C. Project Description

1. Resources:

The resource to be studied by this project is the sea otter.

2. Objectives:

   a. Monitor the recovery of sea otters in oiled areas by determining their abundance, distribution and mortality.

   b. Construct a population model to evaluate the potential recovery of the sea otters.

   c. Identify patterns of habitat use.

   d. Identify and evaluate areas with high value of sea otter habitat within PWS for possible protection.[1]

3. Methods:

   This project addresses population demographics and habitat use analysis. Within these two general areas, there are four related but logistically separate components: (1) population surveys to determine the distribution and abundance of sea otters, (2) beach surveys for recovery of sea otter carcasses, for evaluation of annual patterns of sea otter mortality, (3) population modeling to predict the most important factors affecting recovery of the sea otter population, and (4) habitat analysis, through examination of existing data on sea otter distribution, abundance and movements to evaluate patterns of habitat use by sea otters. The first three components (aerial surveys, beach surveys and population modeling) fall within the general area of population demographics. Methods for each component are presented separately below.

   a. Study Area:

      The study area for all components of this project will be PWS, Alaska.

   b. Population Surveys:

      The distribution and abundance of sea otter populations in PWS will be estimated using aerial surveys. This component of the project will continue work initiated through Restoration Feasibility Project #3, which was conducted in 1991 with Trustee Council funding, and continued in 1992 with USFWS funding. The long-term goal of the aerial survey component is to develop and implement standardized survey methodologies that will provide improved estimates of sea

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[1]This objective is proposed for 1994-95, as a continuation of the work described in the present project description. It will not be included as part of the efforts in the 1993-94 work plan.

otter population abundance and distribution. Attaining this goal will allow greater resolution in detecting changes in sea otter populations affected by the oil spill.

Development of aerial survey methods in PWS began in 1991 and continued through 1992 (Bodkin and Udevitz 1991). This project was initiated as a result of a detection bias identified in the boat surveys being conducted in Prince William Sound (Burn 1993). The aerial methods developed will be implemented as a pilot project within Prince William Sound in 1993. Further developmental work will be conducted in Prince William Sound in 1993 to refine precision of estimates. If the 1993 PWS pilot survey proves feasible on a large scale, a monitoring program throughout the entire spill area will be proposed for 1994 and subsequent years.

The 1991 work consisted of trials to evaluate the Piper PA-18 Super-Cub as a survey platform for estimating sea otter abundance using strip transect methodology. Because sea otters are diving mammals, it cannot be assumed that all otters are detected in a survey. The effects of altitude, search pattern and search intensity on sea otter detectability were evaluated in 1991 (Bodkin and Udevitz 1991). Detection probability on transect counts ranged from 0.52 to 0.72. Detection probability increased with increasing search intensity: after completion of three intensive search unit patterns, detection probability ranged from 0.88 to 0.93.

In 1992 we designed and implemented a trial survey in western Prince William Sound, using the results of our 1991 studies as a foundation. A GPS in the aircraft was used to locate the endpoints of each transect. The study area contained 2,404 km^2, between shore and the seaward boundary. We sampled 616 strip transects, representing 1,936 linear km of transects (744.4 km^2). We conducted 173 intensive search units, each consisting of three concentric circles over a 400 m diameter circle within the width of the survey transect. We observed otters on 34 of those intensive search units, of which 18 were randomly selected and 16 were conducted only when otters were observed. We only used the random intensive search units in calculations below, although there was no significant difference between the detection probabilities estimated by each.

Preliminary estimates and standard errors (SE) from our 1992 trial survey in western PWS are presented in the table below.

	Estimate	SE	% SE
Unadjusted Number	1,973	391	0.20
Correction factor	1.77	0.33	0.19
Adjusted Number	3,493	937	0.27

Our 1992 trial survey made no attempt to stratify. We can likely reduce the proportional SE of the estimates by stratifying based on bathymetry (about 0.85 of our sightings occurred between shore and the 40 m contour); stratification will be implemented in the 1993 pilot survey. Our continued developmental work planned for PWS in 1993 consists of methods to increase the sample size of intensive search units in which sea otters are observed, thereby increasing efficiency and reducing the proportional standard error. Detail on the 1993 survey methods is presented below.

(1) Continued survey development - 1993

The precision of intensive search-based detectability estimates is limited by the number of intensive search units in which otters are observed. In the trial survey conducted in 1992, otters were observed in 18 out of 157 randomly located intensive search units. During the summer of 1993 we will investigate the potential of 2 methods for increasing the sample size of intensive search units containing otters.

The first method locates intensive search units at positions along the strip transects where otters are observed (e.g., an intensive search would be initiated around every k'th group of otters detected along a strip transect). Detection probability estimates would be based on the proportion of the otters detected during the intensive search that were not detected in the initial strip count, excluding the group of otters that initiated the intensive search. This method attempts to take advantage of the relatively clumped nature of sea otter distributions. For a fixed number of intensive search units, the number of units containing otters will be increased by this method if the probability of a sea otter being within approximately 400 m of another sea otter is greater than the probability of being at a random location.

The second method is based on classification of the survey area into two strata. The intensive search effort will be conducted directed entirely in the stratum with the highest sea otter

density. A detectability estimate based on intensive searches in this stratum will be valid for the other (lower density) strata only under the assumption that detectability does not depend on stratum. Strata for this survey will be defined largely by bathymetry, so that the high density stratum will correspond roughly with feeding habitat and the low density stratum will correspond roughly with non-feeding habitat. We hypothesize that any difference in detectabilty between these strata will be mainly due to a reduction in diving behavior (resulting in increased detectability) in the low density stratum. Our approach to minimizing the effect of inter-stratum differences in detectability will be to record the behavior of all groups observed during the intensive searches. Detectability estimates for the high density stratum will be based on all groups. Detectability estimates for the low density stratum will be based on only the non-diving groups observed during intensive searches in the high density stratum.

Survey development field work in 1993 will focus on obtaining data for testing the assumptions upon which each of these methods is based and on investigating the feasibility of applying the methods in a strip transect survey. Forty hours of air time will be devoted to flying strip transects established in the 1992 trial survey. An intensive search will be conducted at each location where an otter group is detected, subject to a minimum spacing of 2 minutes between intensive searches. For each group of otters in each intensive search, the number of otters detected on the initial strip count, the additional number detected during the intensive search, and the behavior of the group (diving versus non-diving) will be recorded. The identity of the group that initiated each intensive search will also be recorded. These data will be used to investigate the assumptions that (1) the probability of a sea otter being within approximately 400 m of another sea otter is greater than the probability of being at a random location, (2) detectability differs between the low and high density strata, and (3) diving behavior is negligible in the low density stratum. We will also investigate the relationship between group size and detectability, and the relationship between actual and observed (during the strip count) group size for detected groups. Depending on the outcome of these investigations, we may incorporate 1 or both of the new methods for locating and using intensive searches in the 1993 survey of Prince William Sound, and we may refine detection probability estimates by estimating actual group size of detected groups as a function of

observed group size, and using logistic regression to estimate the probability of detection as a function of group size.

(2) Pilot survey, PWS - 1993

Prince William Sound will be partitioned with GIS into 400-km wide strip transects 1.2 km apart oriented north and south. Two strata will be defined by bathymetry and sampled proportional to estimated relative sea otter abundance. One strata will consist of transects that intersect the shoreline and extend offshore to the 40 m contour and the second strata will consist of transects that extend offshore from the 40 m contour offshore to a point that is 1-3 km from the 100 m depth contour. We assume no otters occur 3 km beyond the 100 m contour. A systematic sample of these transects will be selected from within each stratum for sampling within the survey area. A GPS will be used to locate the start and end points of strip transects. The aircraft will fly along one edge of each selected transect while the aerial observer records the location, group size, and number of pups in each sea otter group observed within 400 m of the strip transect. The 400 m width of the transect will be maintained using distance indicators marked on the windows and wing struts of the aircraft. The survey will be conducted at an altitude of 91 m above sea level and at a speed of 27 m/s, and only when wind velocities are < 15 knots and visibility > 5 km.

At specified intervals along each transect, the aircraft will circle so that the observer can conduct an intensive search over the portion of the transect just passed. During the intensive search, the aircraft will be piloted along the circumference of a 400 m diameter circle, centered in the transect, while the aerial observer views the circumscribed area and records the circle number, location, group size, and number of pups of each new sea otter or group of sea otters observed during the search. The intensive search pattern will continue through 3 complete circles (approximately 2.4 min) before the strip transect survey is resumed. The intensive search units will provide an estimate of the detection probability of otters on the transect under the conditions of the survey. We anticipate sampling about 3,000 km of strip transects with an area of about 1,200 km^2. We also anticipate sampling a minimum of 25 intensive search areas from which to estimate detection probability in strip counts, conducting searches randomly. Depending on the results of the continued survey development component of this study, we may use the methods developed in that work to

optimize allocation of survey effort between strip transects and intensive search areas.

Transect and intensive search unit data will be entered directly into an electronic data base, with a GPS providing coordinates to the data base for each otter observation and intensive search unit.

The trial survey will result in an estimate of the Prince William Sound sea otter population size, corrected for detectability of sea otters. We will use ratio estimates to correct unadjusted sea otter counts similar to those estimates presented from 1992 (page 4).

c. Mortality Patterns Determined by Beach Surveys:

Mortality patterns, based on age distributions of the dying portion of the population, will be evaluated through recovery of beach-cast sea otter carcasses in western PWS. Beaches in the Green Island area of western PWS and the Olson Bay/Port Gravina area of eastern PWS, surveyed for carcasses in 1976-84 by Johnson (1987), and again in 1990-92 (Monson and Ballachey 1993), will be surveyed in 1993. In addition, a limited number of beaches on Knight, Naked, and Montague Islands, which were surveyed in previous years, will be surveyed in 1993. Beaches will be surveyed once during late April or early May after snow melt but prior to summer revegetation, which may hide carcasses washed high on the beach by winter storms.

Surveys will consist of crews of two people walking along the selected beaches searching for carcasses between the water line and the storm tide line. At least one member of each crew will have experience in beach surveys from previous field seasons. Generally, the search effort will focus on the high tide line and the storm tide line where skeletal remains are often found, while the lower beach is scanned for fresh carcasses. Efforts will be made to check behind large beached logs and other objects which can easily trap carcasses as waves wash over them.

In 1990-92, incidental recovery of carcasses (i.e., recovered by personnel other than sea otter project survey crew members) provided a significant proportion of the total recoveries. Thus, in addition to beach surveys, we will inform other groups working or recreating in PWS of our desire to obtain sea otter carcasses, and establish a protocol for notification of project personnel when a carcass is located so that we can then recover the carcass.

Data recorded for each carcass will include:

(1) relative location of carcass on the beach

(2) relative condition and completeness of carcass

(3) position of remains relative to previous year's vegetation

(4) relative age (adult, subadult, pup)

(5) sex

(6) specimens collected (e.g. entire carcass, skull, baculum, none)

Skulls (when present) will be taken from all carcasses and a tooth extracted for aging (Garshelis 1984). Any fresh carcasses collected will be necropsied as soon as possible and tissue samples collected for potential toxicology and histopathology studies.

Otters will be categorized in three age classes: (1) juvenile, ages 0 and 1, (2) prime, ages 2-8, and (3) older, ages 9 and above. The distribution of age classes of all recovered carcasses will be determined for each area (EPWS and WPWS), and compared with the distribution obtained in other post-spill collections (1990-92) and pre-spill collections (1976-84), using Fisher's Exact Test (2-tailed).

d. Population Modeling:

The population modeling component of this project will integrate existing data bases with data from other project components and ongoing studies to address the status and potential for recovery of the sea otter population in western Prince William Sound. The work for this component will be done at the USFWS offices in Anchorage.

A Leslie matrix model for males and females, age classes 0 through 25, will be constructed following the general approach used by Eberhardt and Siniff (1988) for the Alaska Peninsula sea otter population. Two different versions of the model will be developed based on different assumptions about the growth rate of the population at the time of the spill and the role of density dependent population regulation. Model version 1 will assume that the population had reached carrying capacity and was not growing at the time of the spill, as suggested by Johnson (1987), and that demographic parameters were density dependent. Model version 2 will be based on the assumption that the western population was growing at the annual rate of 3% estimated for the eastern Prince

William Sound population as suggested by Garrott et al. (in prep.) and that demographic parameters were not density dependent. Both versions will approximate the reproductive cycle with an annual birth pulse occurring at the mean birth date (Johnson 1987, USFWS unpublished data) for the population.

The age, sex and reproductive status of sea otter carcasses recovered in western Prince William Sound during the 5 months following the *Exxon Valdez* oil spill (USFWS unpublished data) will provide the primary source of data for estimating the initial values of model parameters. Only those carcasses for which age, sex and reproductive status could be reliably determined and for which necropsy did not indicate a cause of death that was unrelated to oil exposure will be considered. We will assume that these carcasses represented a random sample of the population at the time of the spill. The age structure of the carcass sample will be examined for obvious anomalies that would contraindicate this assumption.

The initial sex and age structure of the population will be estimated directly from the structure of the carcass sample. The carcass sample will be supplemented with data on births at the rehabilitation centers for estimating sex ratio at birth. Age specific fecundity rates will be determined based on the examination of reproductive tracts and lactational status for each of the carcasses (Bodkin et al. 1993). Age specific survival rates will be estimated from the carcass age structure based on the assumption that the structure was stable and that the population was either stationary (Model version 1) or increasing at an annual rate of 3% (Model version 2) using Eberhardt's (1988) modified geometric method. The survival and fecundity rates will be smoothed and extrapolated for the senescing age classes by fitting them to Eberhardt's (1985) survival and maternity functions. Density dependence (Model version 1) will be incorporated as a generalized logistic function that reduces fecundity and early survival as the population size reaches carrying capacity (Eberhardt and Siniff 1988). Carrying capacity for Model version 1 will be assumed to be the estimated population size at the time of the spill.

For Model version 1, the initial population size will be estimated from the Irons et al. (1988) survey of shoreline habitat, adjusted by the ratio of shoreline densities to pelagic and offshore densities obtained by Burn (1993). For Model version 2, we will use the population size estimate obtained by Garrott et al. (in prep.) based on the 1989 boat surveys (Burn 1993) adjusted for the observed growth rate for the eastern Prince William Sound population. Population size estimates obtained from boat surveys in 1990 and 1991 (Burn 1993) will be used to validate the model. Population estimates that will be obtained

from boat (Restoration Project # 93045) and aerial surveys (as part of this project, described above) in 1993 will also be used for model validation.

Additional data collected subsequent to the spill will be used to evaluate and refine the model. G-tests (Sokal and Rohlf 1981) will be used to test whether age and sex structures observed in various components of the population differed from those predicted by the model. The carcass data will be supplemented or replaced for estimating model parameters, depending on whether tests indicate the parameter values have changed. Data sets that are currently available for evaluating and/or refining the model include:

(1) Ages of approximately 30 female sea otters captured with dependent pups in western Prince William Sound during August and September 1992 and sex ratio of the pups (USFWS unpublished data). These data will be used to compare the observed age structure of parturient females and the sex ratio of pups to those predicted by the model.

(2) The age and reproductive status of approximately 15 female sea otters captured in western Prince William Sound during June 1991 (USFWS unpublished data). These data will be used to supplement or replace carcass data for estimating fecundity rates, depending on the outcome of the test for differences.

(3) The age and sex structure of beach cast sea otter carcasses collected in western Prince William Sound during 1990, 1991, and 1992 (Monson 1993) and of carcasses that will be collected in 1993 (as part of this project, described above). These data will be used to compare the observed age and sex structure of dying otters to that predicted by the model.

Additional data sets, including juvenile survival rates from radiotelemetry studies, will be used to validate and refine the model as they become available. The model will be used to predict recovery rates under the assumption that reproduction and survival remain constant, and under a range of alternative assumptions about those rates. The alternative assumptions will include the evaluation of potential strategies to enhance recovery of the population.

e. Identification of Sea Otter Habitat in PWS:

The analysis of patterns of habitat utilization by sea otters will focus on areas in PWS. The analysis will be conducted at the USFWS offices in Anchorage. No collection of new data is planned for this

component. Rather, the intent is to utilize GIS techniques to consolidate existing sea otter data from surveys, radiotelemetry, and capture efforts, and to integrate related existing data on physical and biological properties of the nearshore area to define patterns of habitat use by sea otters in PWS. Continuing efforts planned for 1994-95 will utilize the data base compiled on habitat use patterns to identify and evaluate potential areas of high habitat value in PWS for protection.

There are several phases involved in the habitat analysis effort. Initially, we will inventory and evaluate potentially applicable data sets, and consolidate survey data as appropriate (see below). Following the inventory and evaluation process, subsequent phases of the analysis will include acquisition of relevant data sets not already in our possession, formatting of data sets in preparation for GIS analysis, and data analysis and interpretation.

Data sets already available that will be evaluated include:

(1) sea otter distribution and abundance, from boat-based surveys in PWS in 1984-85 (Irons et al, 1988); in 1989, 1990, 1991 (Burn 1993), and in 1993 (this project)

(2) sea otter distribution and abundance, from aerial surveys, PWS, 1989, 1990 (USFWS unpublished data)

(3) sea otter distribution and abundance, from aerial surveys, PWS, 1993 (conducted as part of this project)

(4) telemetry data on juvenile sea otters, PWS, 1992-93 (USFWS unpublished data) - movements and activities of weanling sea otters

(5) sea otter reproductive surveys in PWS, 1991 (USFWS unpublished data) - relative abundance and distribution of female sea otters with pups

(6) sea floor bathymetry coverages for PWS

Because there are several sources of survey data that were collected under different conditions, the comparability of these data sets will be examined, with consideration of factors such as survey platform used, season of survey, and extent of coverage. As appropriate, data from different surveys will be consolidated to provide a post-spill coverage of sea otter distribution and abundance in PWS. Sea otter densities (abundance per unit area) will be quantified according to bathymetry,

and comparisons made for different seasons (early spring vs. summer only, as little or no data are available for fall and winter distribution).

Additional information that may be useful in defining sea otter habitat and to which otter densities can be related includes abundance and distribution of sea otter prey species, coastline physiography, and sea floor sediment type. The availability and applicability of these data sets will be investigated. Data on the distribution and degree of shoreline oiling, which may be a factor in post-spill distribution of sea otters (Burn 1993) is available and will be incorporated in the analysis of sea otter densities.

A second approach to identifying patterns of habitat use will utilize data collected on juvenile sea otters in eastern and western PWS in 1992-93. This data set includes specific location and behavioral information (e.g., foraging vs. resting) for individual otters over a 10 month period, and will be used to define, for sea otters in their first year of life, physical characteristics of areas used for specific activities.

We will also review available information on sea otter biology pertinent to habitat use and analysis from areas outside of PWS. Finally, information on commercial, subsistence and recreational uses of PWS will be inventoried, as they will be relevant to eventual definition of potential areas of high value sea otter habitat for protection.

4. Alternatives:

Boat-based surveys of marine birds and sea otters (Project # 93045) provide an alternative method for estimation of population distribution and abundance of sea otters in PWS. However, these surveys are not designed specifically for sea otters, are not readily extended to all areas affected by the *Exxon Valdez* oil spill, and have been shown to have bias in detection probability and relatively large standard errors associated with population estimates in PWS (Burn 1993). Thus, development of aerial surveys was initiated in 1991 to provide an improved alternative to the boat surveys.

No alternative methods are known for the beach surveys, population modeling and habitat analysis components of the project.

5. Location:

Surveys to assess population abundance and distribution will be conducted in Prince William Sound (Sound-wide). Surveys for beach-cast carcasses will be done in the Green and Knight Island areas of western Prince William

Sound, and in the Olson Bay/Port Gravina area of eastern PWS. Population modeling and habitat analysis work, which focus on data collected in Prince William Sound, will be conducted in Anchorage.

6. Benefits:

Studies to date have determined that initial damages to the sea otter population were severe (a loss of between 3,500 and 5,000 sea otters), and suggest that chronic damages to sea otters are occurring, delaying recovery of affected populations. Through monitoring of affected populations and evaluation of patterns of habitat use, this restoration project will guide the development of strategies to aid in the recovery of sea otters. The various project activities will enhance our understanding of the demographics of sea otter populations and identify potential sites for protection of sea otter habitat. Protection of habitats important to sea otters will promote population recovery over the long-term as well as provide protection for other members of the nearshore marine community.

7. Technical Support:

None required.

8. Contracts:

Three categories of contracts will be used in this project:

a. Professional services contract, with Drs. L. Eberhardt, of the Battelle Memorial Institute, Richland, WA, and R. Garrott, of the University of Wisconsin. These two scientists have been peer reviewers for sea otter NRDA studies since 1990, and were involved in preliminary examination of the feasibility of modeling sea otter populations in PWS prior to the settlement of oil spill litigation with Exxon in 1991. They are widely recognized as experts in modeling of wildlife populations. A professional contract will be issued to Drs. Eberhardt and Garrott for review of work products produced as part of the population modeling effort, and to provide expert guidance on refining the model developed by USFWS personnel.

b. Flight time for aerial surveys will be arranged with Fishing and Flying, a government-approved air charter service in Cordova, AK. Fishing and Flying provided support for previous aerial survey work (1991, 1992) in PWS.

c. Carcasses recovered on beach surveys will be necropsied (if condition is adequate) by a contract veterinarian experienced in sea otter necropsy. Teeth removed from skulls will be sectioned and aged by

Matson's of Milltown, MT, who processed and aged all sea otter teeth collected as part of NRDA studies.

9. Mitigation Measures:

No adverse effects on sea otters or any other resource are expected as a result of work conducted in this project. No mitigation measures are required.

10. Literature Cited:

Babcock, M., G. Irvine, S. Rice, P. Rounds, J. Cusick, and C.C. Brodersen. 1993. Oiled mussel beds in Prince William Sound two and three years after the *Exxon Valdez* oil spill. Pp. 184-185 *in Exxon Valdez* Oil Spill Symposium Abstracts. 356 pp.

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Burn, D.M. 1993. Boat-based population surveys of sea otters (*Enhydra lutris*) in Prince William Sound, Alaska, in response to the *Exxon Valdez* oil spill. Unpublished NRDA Final Report, U.S. Fish and Wildlife Service, Anchorage.

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Johnson, A.M. 1987. Sea otters of Prince William Sound, Alaska. Unpublished report, U.S. Fish Wildl. Serv., Alaska Fish and Wildlife Research Center. Anchorage, AK. 87 pp.

Monson, D.H. 1993. Age distributions and sex ratios of sea otters found dead in Prince William Sound, Alaska, following the *Exxon Valdez* oil spill. Unpublished NRDA Final Report, U.S. Fish and Wildlife Service, Anchorage.

Monson, D.H., and B.E. Ballachey. 1993. Age distributions of sea otters dying in Prince William Sound, Alaska, after the *Exxon Valdez* oil spill. Pp. 282-284 *in Exxon Valdez* Oil Spill Symposium Abstracts. 356 pp.

Rounds, P., S. Rice, M.M. Babcock, and C.C. Brodersen. 1993. Variability of *Exxon Valdez* hydrocarbon concentrations in mussel bed sediments. Pp. 182-183 *in Exxon Valdez* Oil Spill Symposium Abstracts. 356 pp.

Sokal, R.R., and F.J. Rohlf. 1981. Biometry (2nd edition). W.H. Freeman and Co., San Francisco. 859 pp.

D. Schedules and Planning

1. Milestone Dates for Restoration Activities:

ACTIVITY	COMPONENT OF PROJECT: POPULATION SURVEYS	BEACH SURVEYS	POPULATION MODELLING	HABITAT ANALYSIS
Data Collection and/or Compilation	July and August 1993	April to June 1993	April to June 1993	April, May 1993
Data Analysis	September to December 1993	July 1993	July to November 1993	June to December 1993
Draft Report to Peer Review	February 1, 1994	February 1, 1994	February 1, 1994	February 1, 1994
Final Report Completed	March 31, 1994	March 31, 1994	March 31, 1994	March 31, 1994
Primary Personnel Responsible for Report Generation	Bodkin Udevitz	Ballachey	Ballachey Udevitz	Boyle Ballachey Bodkin

2. Project Personnel:

Leslie Holland-Bartels	Project Manager with oversight for all aspects of sea otter oil spill research program.
Brenda Ballachey	Project Leader with day to day responsibility for coordination of project activities, including budget management and product development. Specific responsibilities in beach survey, population modeling and habitat analysis components; will assist with field work and data analyses on all components.
James Bodkin	Wildlife biologist responsible for population surveys, in conjunction with M. Udevitz. Will support habitat analysis component, and assist other project activities as needed.

Mark Udevitz	Biostatistician responsible for population surveys, in conjunction with J. Bodkin, and for population modeling, in conjunction with B. Ballachey.
Barbara Boyle	GIS specialist responsible for habitat analysis component, with support from B. Ballachey and J. Bodkin.
Dana Bruden	Biotechnician supporting all components of project, with emphasis on GIS, data base management, and data analyses.
Michael Fedorko	Biotechnician supporting field activities, assisting with data collection (population and beach surveys), input and analyses.
Kelly Modla	Biotechnician assisting with data collection (population and beach surveys).

3. Logistical Needs:

Logistical needs are of importance for the population (aerial) and beach survey components. Aerial surveys require services of a federally approved aircraft service with a PA-18 Supercub. Previous survey work in PWS has been conducted with Fishing and Flying, operating out of Cordova, AK, and we plan to use their services again for the 1993 survey. Survey operations will be centered out of Cordova, and any necessary ground support will be supplied by the USFWS sea otter project. For the beach surveys, the sea otter project has a 25' Boston Whaler that will be available to transport the survey crew in PWS. An inter-agency agreement with the U.S. Forest Service (Cordova District) provides for use of the USFS Green Island cabin by the beach crew while working in western PWS. In eastern PWS, the crew will be based out of Cordova. No other logistical needs are anticipated.

E. Environmental Compliance/Permit/Coordination Status

The field work components of the study rely on observations from airplanes and boats, and this is a non-intrusive study. Based on a review of CEQ regulation 40 CFR 1500-1508, this study has been determined to be categorically exempt from the requirements of NEPA, in accordance with 40 CFR 1508.4.

F. Performance Monitoring

1. Back-up Strategy:

All personnel are expected to be with the project for the duration of the work period (April 1993 - March 1994). If, however, key personnel leave during the course of the study, the change would be handled in one of several ways: (1) new hires of qualified personnel, (2) reassignment of wildlife biologists with expertise in sea otters and related areas from within the USFWS, (3) greater reliance on contract personnel, or (4) existing project staff assume greater responsibility for the component in question (depending on the flexibility of their other obligations). Which of these approaches would be utilized would depend in large part on the time frame and specific personnel changes.

2. Quality Assurance and Control Plan

This project will be conducted at the Alaska Fish and Wildlife Research Center (AFWRC) of the USFWS, located in Anchorage. Dr. Leslie Holland-Bartels, as Chief of the Marine Mammals and Fisheries Branch, will have oversight responsibility for the project. Project personnel are all employees of the AFWRC. Dr. Brenda Ballachey, Project Leader for sea otter oil spill studies, will have primary responsibility for project management, with support from Mr. Jim Bodkin, Project Leader for sea otter base research studies.

Project dates/deadlines for products will be monitored by Brenda Ballachey. Biweekly staff meetings will be held to ensure work is progressing on all components in a timely manner, and to identify and respond to any specific issues or concerns. All reports generated will be subjected to an internal review process prior to submission to the Chief Scientist. Ultimate responsibility for product quality and meeting of deadlines will lie with Dr. Holland-Bartels.

3. List of Products

The final products of this project will be four reports, one on each component of the project, as identified under "D. Schedules and Planning" above.

G. Personnel Qualifications

1. Leslie Holland-Bartels - Project Manager

Leslie Holland-Bartels received her B.S. (1975) from the University of Massachusetts majoring in Marine Fisheries, M.S. (1977) in Fisheries with a minor in Statistics from Louisiana State University, and Ph.D. (1980) at Purdue University, with a major in Fisheries. She headed the River Ecology Program of the U.S. Fish and Wildlife Service's National Fisheries Research Center in La Crosse, Wisconsin from 1980 to 1990 and conducted research on fish recruitment, navigation and hydropower impacts, as well as endangered species work. In 1990, Dr. Holland-Bartels became Deputy Assistant Regional Director for Fisheries for the Service's Southeast Region. She directed the Service's anadromous fish restoration program in the South Atlantic and Gulf of Mexico. She joined the Alaska Fish and Wildlife Research Center in August of 1992 as the Chief of Marine Mammals and Fisheries and has oversight responsibility for the Center's Oil Spill program and sea otter research among other areas. Dr. Holland-Bartels has authored or co-authored 27 refereed journal articles and book chapters.

2. Brenda E. Ballachey - Project Leader

Brenda Ballachey received her B.S. (1974) and M.S. (1980) at Colorado State University, majoring in Animal Science, and her Ph.D. (1985) at Oregon State University, with a major in Animal Breeding and Genetics and minors in Statistics and Genetics. She did a post-doctorate at South Dakota State University, studying the use of flow cytometric analyses of sperm and other tissues as (1) a biomarker of chemical exposure, and (2) an indicator of male fertility. Subsequently, she served as staff officer at the National Research Council in Washington, D.C., for a project entitled "Managing Global Genetic Resources." Dr. Ballachey joined the sea otter project at the AFWRC in November 1989, and assumed Project Leader responsibilities for oil spill studies in the summer of 1990. During that period, she has been involved in all aspects of the NRDA sea otter studies, including field work, data base management, and coordination of ongoing efforts with pathologists. She is currently managing a telemetry study on juvenile sea otter survival in Prince William Sound as well as overseeing the preparation of final reports on NRDA sea otter studies. Dr. Ballachey has authored or co-authored 11 refereed journal articles and book chapters.

Key Relevant Publications - B.E. Ballachey

Lipscomb, T.P., R.K. Harris, R.B. Moeller, J.M. Pletcher, R.J. Haebler, and B.E. Ballachey. 1993. Histopathologic lesions in sea otters exposed to crude oil. Vet. Path. 30:1-11.

DeGange, A.R, B.E. Ballachey, and K. Bayha. Release strategies for rehabilitated sea otters. Chapter 14 *in* Rehabilitating Oiled Sea Otters and Other Fur Bearing Marine Mammals. T. Williams and R. Davis, Eds. In press.

Stegeman, J.J., B. Ballachey, J. Bickham, B. Hocker, S. Kennedy, H. Thompson and, D. Vethaak. 1992. Implementation of biomarker-based studies. Chapter 3 *in* Strategy for Biomarker Research and Application in the Assessment of Environmental Health. D.B. Peakall and L.R. Shugart, Eds. Springer-Verlag, Belgium.

Bodkin, J.L., B.E. Ballachey, and M.A. Cronin. 1992. Mitochondrial DNA and the conservation and management of sea otters. Research Information Bulletin. No. 37, U.S. Fish and Wildlife Service, Office of Information Transfer.

Monson, D.H. and, B.E. Ballachey. 1993. Age distributions of sea otters dying in Prince William Sound, Alaska, after the *Exxon Valdez* oil spill (extended abstract). Pp. 282-284 *in* Proceedings of The *Exxon Valdez* Oil Spill Symposium. 356 pp.

Mulcahy, D., and B.E. Ballachey. 1993. Hydrocarbon concentrations in tissues of sea otters collected following the *Exxon Valdez* oil spill (extended abstract). Pp. 293-295 *in* Proceedings of The *Exxon Valdez* Oil Spill Symposium. 356 pp.

3. James L. Bodkin - Wildlife Biologist

James L. Bodkin received his B.S. (1976, Biology) from Long Beach State University and his M.S. (1985, Wildlife Biology) from California Polytechnic State University, San Luis Obispo, CA. He has been employed by the Research Division of the U.S. Fish and Wildlife Service since 1980 and has been conducting research on sea otter ecology and natural history for 12 years. His present position is Sea Otter Research Project Leader, Alaska Fish and Wildlife Research Center, U.S. Fish and Wildlife Service, Anchorage, Alaska. He is responsible for the design and implementation of sea otter research in Alaska. Responsibilities include development and design of study proposals and study plans, supervision of research staff and projects, direction of annual funding allocations and preparation of results. Jim has been involved with the *Exxon Valdez* oil spill since March of 1989, initially in response efforts and subsequently in NRDA and Restoration sea otter projects. Jim has authored or co-authored 11 refereed journal articles or book chapters, 7 of which have been about sea otter biology or ecology.

Key Relevant Publications - J.L. Bodkin

Bodkin, J.L., R.J. Jameson, and G.R. VanBlaricom. 1985. Pup production, abundance, and breeding distribution of northern elephant seals on San Nicolas Island, Winter 1981. Calif. Fish and Game 71(1):53-59.

Jameson, R.J., and J.L. Bodkin. 1986. An incidence of twinning in the sea otter (*Enhydra lutris*). Marine Mammal Science 2(4):304-309.

Bodkin, J.L., and F. Weltz. 1990. A summary and evaluation of sea otter rescue operations in response to the *Exxon Valdez* oil spill, Prince William Sound, Alaska, 1989. Pp. 61-69 in Sea Otter Symposium, Anchorage, Alaska, 17-19 April 1990.

Bodkin, J.L., and R. Jameson. 1991. Patterns of seabird and marine mammal carcass deposition along the central California coast, 1980-1986. Can J. Zool. 69:1149-1155.

Osborne, T.O., T.F. Paragi, J.L. Bodkin, A.J. Loranger, and W.N. Johnson. 1992. Extent, causes and timing of moose calf mortality in western interior Alaska. 27th North American Moose Conference. Anchorage, Alaska. 13-17 May 1991. Alces 27:24-30.

Bodkin, J. L., B.E. Ballachey, and M. Cronin. 1992. Mitochondrial DNA and the conservation and management of sea otters. Research Information Bulletin No. 37. U.S. Fish and Wildlife Service, Office of Information Transfer.

Bodkin, J. L., D. Mulcahy, and C.J. Lensink. Age specific reproduction in the sea otter (*Enhydra lutris*): an analysis of reproductive tracts. Accepted for publication, Can. J. Zool.

4. Barbara Boyle - Computer Analyst/Biologist

Barbara Boyle received her B.S. in Zoology from the University of Georgia in 1985. Since 1985, she has been employed by the U.S. Fish and Wildlife Service in Alaska, where she has specialized in the use of Geographic Information Systems (GIS) for natural resource applications. As a member of NRDA Technical Service Study Number 3, GIS Technical Group, since 1989, Barbara has been active in supporting the use of GIS related to the *Exxon Valdez* oil spill. In particular, she has worked closely with the Sea Otter, Bald Eagle, Marbled Murrelet and Boat Survey projects developing geographic databases, completing statistical summaries and generating map products.

5. Mark S. Udevitz - Biostatistician

Mark Udevitz received a B.S. degree in Wildlife Biology from Colorado State University in 1979, an M.S. degree in Wildlife Management from West Virginia University in 1982 and a Master of Statistics degree from North Carolina State University in 1986. He earned a Ph.D. in Biomathematics and Statistics in 1990 from North Carolina State University with a dissertation in the area of wildlife population estimation. He worked as a statistical consultant with the Southeastern Cooperative Wildlife and Fisheries Statistics Project from 1983-1989. Since 1990, Dr. Udevitz has worked as the Statistician for the Marine and Terrestrial Mammals Branches of the Alaska Fish and Wildlife Research Center. During this time he has had extensive involvement in the development of sampling, experimental and analytical protocols and in the conduct of data analyses for NRDA and other sea otter research undertaken by the Center. Dr. Udevitz has authored or co-authored 7 refereed journal articles and book chapters.

Key Relevant Publications - M.S. Udevitz

Bodkin, J. L. and M. S. Udevitz. 1993. An intersection model for estimating sea otter mortality following the *Exxon Valdez* oil spill (extended abstract). Pp. 289-291 *in* Proceedings of The *Exxon Valdez* Oil Spill Symposium. 356pp.

Udevitz, M. S. and K. H. Pollock. 1992. Change-in-ratio methods for estimating population size. Pp. 90-101 *in* D. R. McCullough and R. H. Barrett, eds. Wildlife 2001: Populations. Elsevier Science Publishers, London, England. 1163pp.

Udevitz, M. S. and K. H. Pollock. 1991. Change-in-ratio estimators for populations with more than 2 subclasses. Biometrics 47(4):1531-1546.

Douglas, D. C., M. S. Udevitz, J. R. Gilbert and D. O. Hunter. 1991. Evaluation of airborne videography for enumerating pacific walruses (*Odobenus rosmarus divergens*) on sea-ice haulouts. Pp. 507-513 *in* Proc. Resour. Technology 90, Int. Symp. on Advanced Technology in Nat. Resour. Manage. Am. Soc. Photogram. and Remote Sensing, Falls Church, Va.

H. Budget

The budget presented below includes several modifications to the original budget submitted with the preliminary draft study plan. The total for FY93 is decreased by $27.6K, from $291.9K to $264.3K (period of performance: April to September

93). The budget for FY94, to closeout work started in FY93, was initially projected at $145.5K and is now projected at $133.9K (period of performance: October 93 to March 94). The decrease in the FY93 budget results primarily from several major changes, described below. Other budget changes are minor and reflect salary increases anticipated in the upcoming year.

1. Wildlife biologist - 6.6 months (33K) were allocated in the original budget for wildlife biologist salary (Ballachey and Bodkin). The new budget includes 4.8 months (25K) for wildlife biologist salary for Ballachey, and no salary for Bodkin, as his salary is covered by the USFWS.

2. Biologist & GIS specialist - 3.6 months (12.6K) was identified for a biologist, and 3.6 months (17K) for a GIS specialist in the original budget. In the revised budget, the GIS specialist is listed for 4.8 months (22.9K), and no biologist will be hired. The GIS specialist, Barbara Boyle, will assume a major role in the habitat analysis rather than a support role, as originally planned.

3. Population surveys (developmental work) were initially planned for an area within the oil spill zone but outside of PWS; the budget associated with this component of the survey was approximately $20.0K. Given other sea otter program (non-oil spill related) demands and the additional developmental work to be conducted on population surveys within PWS as part of this study, we canceled plans to do surveys outside PWS as part of this project in 1993.

Project Description: Sea otter recovery evaluation, population assessment and synthesis of habitat information to determine geographic areas of high value to sea otters.

Budget Category	Approved 1-Oct-92 28-Feb-93	Proposed* 1-Mar-93 30-Sep-93	Total FY 93	FY 94 **	FY 95	FY 96	FY 97	Sum FY 98 & Beyond
Personnel	0.0	142.8	142.8	109.9				
Travel	0.0	10.0	10.0	0.0				
Contractual	0.0	42.7	42.7	0.5				
Commodities	0.0	16.9	16.9	5.0				
Equipment	0.0	27.5	27.5	2.0				
Capital Outlay	0.0	0.0	0.0					
Sub-total	0.0	239.9	239.9	117.4	0.0	0.0	0.0	0.0
General Administration	0.0	24.4	24.4	16.5	0.0	0.0	0.0	0.0
Project Total	0.0	264.3	264.3	133.9	0.0	0.0	0.0	0.0
Full-time Equivalents (FTE)	0.0	2.9	2.9	2.4	Amounts shown in thousands of dollars.			

Budget Year Proposed Personnel: Position	Months budgeted	Cost	Comments
Supervisory Biologist	1.2	7.8	
Biostatistician	3.6	21.1	
Program Manager	3.0	15.0	
Wildlife Biologist	4.8	25.0	
GIS Specialist	4.8	22.9	
Biotechnician (2)	8.0	24.0	
Clerical	3.0	9.0	
Biotechnician	6.0	18.0	

*FY 93 is a transition year from the previously used oil fiscal year to the federal fiscal year.
**The total shown in FY 94 is to closeout work started in FY 93.

		Proposed
Travel:	To Prince William Sound	5.5
	Per diem	4.5
Contractual:	Aircraft charter: in Prince William Sound (136 hrs @ 170/hr)	23.1
	Tooth reading	0.6
	Shipping	0.5
	Necropsies	0.5
	Consultants	18.0
Commodities:	Fuel (1800 gal @ 3/gal)	5.4
	Field camp supplies and food	4.5
	Office supplies, books	2.0
	Computer training (ARCINFO)	3.0
	Miscellaneous	2.0
Equipment:	Safety gear	4.5
	Vessel maintenance	10.0
	Computer hardware/software	5.0
	Radio equipment and miscellaneous	8.0

93047 +
NOAA Component
and Part 3

DETAILED RESTORATION PROJECT DESCRIPTION

Project Title: Subtidal Monitoring: Recovery of Sediments, and Hydrocarbon-degrading Microorganisms in the Subtidal Environment.

Project ID Number: 93047

Project Type: Subtidal.

Project Leaders: Charles E. O'Clair, Joan F. Braddock and Stanley D. Rice

Lead Agency: National Oceanic and Atmospheric Agency.

Cooperating Agencies: Alaska Department of Environmental Conservation/University of Alaska Fairbanks.

Project Cost: NOAA: $325.5 K UAF: $69.6 K (Total: $395.1 K)

Start Date: 1 Mar 1993 **Finish Date:** 31 Mar 1994

Geographic Area of Project: Prince William Sound.

Project Leader Signature: Stan Rice

Project Manager:

Name: Bruce Wright Bruce Wright

Signature:

A. Introduction

Oil became broadly distributed in subtidal sediments in Prince William Sound (PWS) during the first three years following the *Exxon Valdez* oil spill. Subtidal sediments were contaminated by *EXXON VALDEZ* oil (EVO) at no fewer than 17 locations in Prince William Sound in 1989, 20 locations in 1990 and 15 locations in 1991. Contamination of subtidal sediments by EVO at oiled locations reached a depth of at least 20 m at 7 locations in 1989, 18 locations in 1990 and 10 locations in 1991 (O'Clair et al. in prep.) In 1989 the EVO was detected mostly at shallow depths (0-20 m) where oil concentrations attained the highest values (O'Clair et al. 1993). Sediments collected at 40 and 100 m contained relatively low concentrations of EVO in 1989. In 1990 and 1991 the EVO was found at greater depths (20-100 m) at most sites, but concentrations generally remained relatively low at these depths. Wolfe et al. (in prep.) estimate that 12% of the spilled oil was transported to the subtidal region by October 1992. We did not sample subtidal sediments in 1992 and therefore do not know the current status of recovery.

The total numbers and activity of hydrocarbon -degrading bacteria were monitored from July 1989 to June 1991 in sediments impacted by the *Exxon Valdez* oil spill. Assessment of the microbial populations is an essential component of oil spill monitoring since the ultimate fate of spilled petroleum depends to a major degree on the ability of microorganisms to use hydrocarbons as a source of carbon and energy (Leahy and Colwell 1990). We have found that in Prince William Sound the numbers and activity of hydrocarbon-degrading microorganisms are indicators of the presence of hydrocarbons in sediments. These parameters also can be used to provide evidence for in situ biodegradation (Madsen et al. 1991). In addition, monitoring microbial populations is a tool for assessing the long-term harmful effects of the spill and for assessing the restoration of the sound. For example, populations of hydrocarbon degrading microorganisms dropped substantially in most surficial intertidal sediments from 1989 to 1991. However, high numbers still existed on several shorelines in 1991 particularly in buried sediments. In these sediments hydrocarbon degrader population numbers and activities were as great as seen in early summer 1989.

B. Project Description

1. Resources:

This project will monitor the recovery of subtidal sediments and the responses of hydrocarbon-degrading microorganisms at 10 locations in Prince William Sound in the fourth year after the spill. An important component of the study will be to track the loss of oil from the subtidal environment in the spill area and to evaluate the potential for long-term contamination of the subtidal environment by *EXXON VALDEZ* oil.

2. Objectives:

a. (NMFS, O'Clair) Determine the composition and concentration

of petroleum hydrocarbons from the *EXXON VALDEZ* oil spill in intertidal and subtidal sediments (0-100 m) in Prince William Sound by gas chromatography-mass spectrometry.

b. (ADEC/UAF, Braddock) Monitor numbers of hydrocarbon-degrading bacteria and the continuing potential for biodegradation of selected hydrocarbon substrates in intertidal and subtidal sediments from oiled and unoiled sites.

3. **Methods:**

a. Sample Collection

(1) Sediments

Intertidal sediment collections for hydrocarbon analysis will be made at about mean lower low water (0 m) by beach teams or divers depending on the stage of the tide. Subtidal sediment collections will be made at depths of 3, 6, 20, 40 and 100 m below mean lower low water. Collections at 3, 6 and 20 m will be made by divers on transects laid along the appropriate isobaths. Three samples each a composite of 8 subsamples collected randomly along a 30 m transect laid along the appropriate isobath will be taken at each of the shallow stations (0 - 20 m).

A stainless-steel Smith-McIntyre grab (1990-91) will be used to collect samples at 40 and 100 m depths. Three grab samples will be taken at each depth. Four cores will be removed from randomly selected points within each grab. The subsamples will be combined to form one sample per grab.

All samples collected by hand (including those removed by hand from the grab) will be taken from the surface (top 0-2 cm) of the sediment column. Samples taken by hand in the intertidal region or by divers will be collected using a stainless steel core tube or spoon. Each subsample will be transferred to a sample jar using a spatula. The core tube and the spatula will be washed, dried and rinsed with methylene chloride between sampling periods. Samples will be placed in jars certified hydrocarbon-clean to EPA standards. Samples will be kept cool after collection and frozen within a few hours. Appropriate blanks will be collected at each site. Chain of custody procedures will be followed after collection of all samples. Sediment samples will be analytically screened using ultraviolet fluorescence as adapted from Krahn et al. (1991). Selected sediments will then be analyzed by gas chromatography/mass spectroscopy (GC/MS) for quantitation of specific analytes (Larsen et al. 1992).

(2) Microbiology

Microbiology sediment samples from the intertidal and shallow subtidal areas will be obtained from the shore parties and divers collecting samples for hydrocarbon chemistry analysis. Three samples, each a composite of eight subsamples collected randomly along 30 m transects laid parallel to the shoreline, will be taken at each intertidal and shallow subtidal site. We plan to also collect subsurface intertidal samples at as many shoreline sites as are feasible. Microbiology samples from deeper subtidal areas will be obtained from the Smith-McIntyre grab sampler at the same stations and times as those collected for chemistry analysis. Three grabs will be taken at each depth. Four subsamples will be removed at randomly selected points within each grab.

Sediment samples for microbiological analyses will be collected in sterile Whirlpak bags. Care will be taken to avoid contamination of samples by the sampling personnel and cross-contamination between different sediment samples. Sampling apparatus will be disinfected with alcohol between samples. Samples obtained from the deeper water grabs will be collected from the center of the core to avoid surface contamination incidental to sample handling. Samples will be stored in coolers until they can be processed (within three hours of collection) on the ship. Sample collection will be conducted from 7 to 19 July 1993.

b. Estimation of Hydrocarbon-Degrading Microorganisms

The number of hydrocarbon-oxidizing microorganisms in each sample will be determined by the Sheen Screen most probable number technique (Brown and Braddock 1990). While no technique to enumerate specific metabolic types of microorganisms in marine sediments is absolute, the Sheen Screen technique which uses disruption of an oil film to indicate the presence of hydrocarbon-metabolizing microorganisms in various dilutions of sample, gives consistent results that are appropriate for relative comparisons among stations, depths, and time. Marine heterotrophs may be enumerated at some sites in a similar manner, except that the growth medium will be marine broth and growth will be scored by presence of turbidity (Lindstrom et al. 1991). For both types of samples, one set of plates will be prepared from each replicate sediment sample to yield triplicate values. The plates will be incubated at ambient laboratory temperature for three weeks before being scored. All final values will be corrected to dry weight sediment.

c. Hydrocarbon Oxidation Potential

Radiorespirometry will be used to assay the hydrocarbon-oxidation potential of microorganisms in sediment slurries (Brown et al., 1991; Lindstrom et al., 1991). [1-^{14}C]-hexadecane and [9-^{14}C]-phenanthrene (specific activity of each undiluted isotope is 5 mCi/mmol) will be used as representative aliphatic and polycyclic aromatic

hydrocarbons. Sediment slurries will be prepared by mixing 1:10 (wt/vol) in a sterile flask containing a mineral medium (no organic carbon source). Ten-ml aliquots of the sediment slurry will be pipetted into 40-ml Teflon-lined septa vials. Each vial will then be injected with 50 l of a 2 g/l solution of a radiolabelled hydrocarbon (in acetone). The resulting initial concentration of added hydrocarbon will be 100 g/ vial (100 g/g wet sediment; approximately 50,000 dpm). After incubation (48 hr for hexadecane and 72 hr for phenanthrene) the samples will be "killed" and the CO_2 fixed by the addition of 1 ml of 1N NaOH. The vials will be returned to the laboratory at the University of Alaska.

To recover the $^{14}CO_2$ in each killed sample, the sample will first be acidified with 1.5 ml of 12 N HCl. The acidified samples will then be purged for 15 min with N_2 gas (30 ml/min) through a Harvey trap (Harvey Biological Supplies, Hillsdale, NJ.) containing 15 ml of acidified toluene. The trap effectively scavenges unoxidized or partially oxidized volatile hydrocarbon purged from the sample along with the CO_2 (see also Brown et al. 1991 and Lindstrom et al. 1991). After passing through the Harvey trap, the gaseous stream will be bubbled through a standard liquid scintillation vial containing 10 ml of CO_2-sorbing phenethylamine cocktail. The radioactivity will be measured with a model LSC 1800 liquid scintillation counter (Beckman Instruments, Irvine, CA) with automatic quench correction.

For each sample time-zero controls will be subtracted from the sample DPM value to yield a corrected DPM value. This corrected value will be divided by the added DPM value to obtain the percent mineralization of added hydrocarbon substrate. The percent hydrocarbon mineralized, in units of percent CO_2 evolved divided by the time of incubation, is referred to as the mineralization potential of the sample.

Positive controls have shown that the purging system will recover greater that 99% of $^{14}CO_2$ from processed radiolabelled bicarbonate run as if it were a sediment sample (see Braddock et al. 1990). The potential for carryover between samples is monitored by periodically running blank controls through the purging line. Blank controls run in this manner always fall within the range for time-zero control samples.

4. Alternatives:

In order to ensure that our chemical and microbiological results will be comparable to those obtained in the first three years following the EXXON VALDEZ oil spill we have chosen to avoid as much as possible additional sources of bias and error that can reduce data quality when alternative methodologies are substituted for those that were initially put in place and have proven to be reliable.

5. **Location:**

Study locations will be within Prince William Sound. Sediments will be collected at five oiled and five reference sites. The oiled sites will include Herring Bay, Northwest Bay, Sleepy Bay, Snug Harbor, and Bay of Isles. The reference sites will include Drier Bay, Lower Herring Bay, Moose Lips Bay, Olsen Bay, and Zaikof Bay. All sites were sampled repeatedly under the NRDA program.

6. **Benefits:**

Documentation of the changes in concentrations of petroleum hydrocarbons in subtidal sediments will benefit investigators attempting to restore or monitor recovery of populations of subtidal organisms or demersal species that forage in subtidal habitats because it will provide them with information on what concentrations of petroleum hydrocarbons are currently present in the environment of these organisms. This information will help investigators to better evaluate the potential for sub-lethal impacts on subtidal or demersal organisms as a result of contamination from residual hydrocarbons in subtidal sediments. We anticipate that complete recovery to background levels of petroleum hydrocarbons in subtidal sediments in the Sound is likely to take place in several years. However, as of September 1991 we had no evidence that subtidal concentrations of EXXON VALDEZ oil were approaching background levels.

Microbial monitoring has already been shown to be a successful mechanism for use as an indicator of microbial contamination in Prince William Sound, as an indicator of mobilization of oil to deeper sediments with time and as an indicator of in situ biodegradation (Braddock et al. 1993). While chemical analysis is essential, we have found that relatively rapid microbial assays can yield a great deal of information about processes occurring in subtidal and intertidal sediments. These processes effect organisms at all trophic levels. For example, results from other oil spills and from invertebrate studies in Prince William Sound (Feder, person. comm.) show that bays may become at least temporarily anoxic after a large oil spill. Anoxia can result from unusually large carbon inputs to the benthos after an oil spill from inputs of dead plant and animal material as well as some of the spilled oil. Since carbon is often in short supply in deeper sediments, inputs can cause increases in respiratory activities of microbial populations. Since petroleum is essentially non-degradable in anaerobic systems this has a direct effect on any oil remaining in these sediments. In addition, the environment may become inhospitable for higher organisms.

Microbial assays are an effective tool to aid in assessing the extent of the effect of the oil spill, the long-term harmful effects of the spill and to help in determining the rate of restoration of oil affected areas to pre-spill conditions.

8. **Technical Support:**

We do not anticipate needing technical support. Hydrocarbon chemistry will be performed by Auke Bay Laboratory staff. Hydrocarbon data will be submitted to Sid Korn for incorporation into the hydrocarbon database.

9. **Mitigation Measures:**

Because it is not anticipated that this study will have a significant effect on the environment no mitigation measures are planned.

10. **Literature Cited:**

Braddock, J.F., J.E. Lindstrom and E.J. Brown. 1990. Microbial hydrocarbon degradation in sediments impacted by the Exxon Valdez oil spill. Final Report to Science Applications International Corporation for the National Oceanic and Atmospheric Administration, NOAA contract number 50-DSNC-8-00141.

Braddock, J.F., B.T. Rasley, T.R. Yeager, J.E. Lindstrom and E.J. Brown. 1992. Hydrocarbon mineralization potentials and microbial populations in marine sediments following the Exxon Valdez oil spill. Final Report to Alaska Department of Environmental Conservation.

Braddock, J.F., J.E. Lindstrom, T.R. Yeager, B.T. Rasley, G. Winter and E.J. Brown. 1993. Microbial activity in sediments following the T/V Exxon Valdez oil spill. Exxon Valdez Oil Spill Symposium, February 2-5, 1993, Anchorage, AK. Program and Abstracts pp. 52-54.

Brown, E.J. and J.F. Braddock. 1990. Sheen Screen: a miniaturized most-probable-number method for enumeration of oil-degrading microorganisms. Appl. Environ. Microbiol. 56:3895-3896.

Brown, E.J., S.M. Resnick, C. Rebstock, H.V. Luong and J.E. Lindstrom. 1991. UAF radiorespirometric protocol for assessing hydrocarbon mineralization potential in environmental samples. Biodegradation 2:121-127.

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

Larsen, Marie, Larry Holland, Dan Fremgen, Josefina Lunasin, Mona Wells, and Jeffrey Short. 1992. Standard operating procedures for the analysis of petroleum hydrocarbons in seawater, marine sediments, and marine faunal tissue at the Auke Bay Laboratory. Internal document. Auke Bay Laboratory, Alaska Science Center, NMFS, NOAA, 11305 Glacier Highway, Juneau, Alaska 99801-8626.

Leahy, J.G. and R.R. Colwell. 1990. Microbial degradation of hydrocarbons in the environment. Microb. Rev. 54:305-315.

Lindstrom, J.E., R.C. Prince, J.C. Clark, M.J. Grossman, T.R. Yeager, J.F. Braddock and E.J. Brown. 1991. Microbial populations and hydrocarbon biodegradation potentials in fertilized sediments affected by the T/V Exxon Valdez oil spill. Appl. Environ. Microbiol. 57:2514-2522.

Madsen, E.L., J.L. Sinclair and W.C. Ghiorse. 1991. In situ biodegradation: microbiological patterns in a contaminated aquifer. Science 252:830-833.

O'Clair, C.E., J.W. Short and S.D. Rice. 1993. Contamination of subtidal sediments by oil from the EXXON VALDEZ in Prince William Sound, Alaska. Exxon Valdez Oil Spill Symposium, February 2-5, 1993, Anchorage, AK. Program and Abstracts pp. 55-56.

O'Clair, C.E., J.W. Short and S.D. Rice. In prep. Petroleum hydrocarbon-induced injury to subtidal marine sediment resources. Available Auke Bay Lab., 11305 Glacier Highway, Juneau, AK 99801.

Wolfe, D. A., M. J. Hameedi, J. A. Galt, G. Watabayashi, J. Short, C. O'Clair, S. Rice, J. Michel, J. Payne, J. Braddock, S. Hanna and D. Sale. In prep. Fate of the oil spilled from the T/V EXXON VALDEZ in Prince William Sound, Alaska. Available NOAA/ORCA22, Rm. 323, Bldg. WSC-1, 6001 Executive Blvd., Rockville, MD 20852.

C. Schedules and Planning

Sediment sampling for hydrocarbon analysis and for microbiological studies will be conducted concurrently from a chartered vessel. The competitive bid procedures for the vessel charter will be initiated in March 1993. The sites in Prince William Sound will be sampled in July 1993. For the sediment contamination and microbial studies, data analysis and compilation will occur from July through December 1993. Separate draft reports on hydrocarbon analysis and microbiology will be generated by January 1993. Final reports will be completed by March 1994.

D. Environmental Compliance/Permit/Coordination Status

It is not anticipated that this study will have a significant effect on the environment and an Environmental Impact Statement or Environmental Assessment will not be necessary.

E. Performance Monitoring

The project leader for the sediment contamination study (CEO) will supervise the collection of sediments, oversee chain of custody procedures in the field, perform data analysis and draft reports. J. W. Short of the Auke Bay Laboratory will manage the chemical analyses, ensure compliance with the quality-assurance and control plan for the hydrocarbon analyses and assist in the interpretation of the chemical

results. S. D. Rice will monitor the progress of the project, quality control the design of it, oversee the implementation of it and review the budget, progress toward completion of the final products and interpretations of the results contained within the products.

The project leader for the microbial studies will be Joan Braddock from the University of Alaska Fairbanks. She will supervise the collection of sediments for the microbial studies and will oversee data collection and analysis and the completion of reports on the microbial studies. Quality assurance of the microbial studies will be as follows.

The most probable number (MPN) enumeration procedure is a statistical method. The MPN procedure used in this study is a "five-tube" MPN, statistically more reliable than the more commonly used three-tube method. Positive results in the MPN procedure will be scored when the sheen of pre-sterilized oil applied to the surface of the media is emulsified. Negative controls are periodically run by preparing sterile media plates not inoculated with sample. Emulsification is not observed on these plates (see also Braddock et al. 1990). Triplicate samples will be run from each sample as described in the methods section.

A number of controls have been run to assure the quality of the data for the biodegradation potentials. These include time zero killed controls to monitor for abiotic CO_2 production, CO_2 recovery efficiencies (see methods section) and careful monitoring of leaking vials as the vials are purged by looking for bubble production after application of soap solution.

F. Personnel Qualifications

(See attached.)

Personal Qualifications

CHARLES E. O'CLAIR S.S. No.: 012-32-1851

Personal: Born May 29, 1941; Ayer, Massachusetts

Education: University of Massachusetts, B.S., Zoology, 1963
University of Washington, Ph.D., Fisheries, 1977

Experience: 1977 - present: Fishery Biologist (Research), National Marine Fisheries Service, Auke Bay Laboratory, Juneau, Alaska. Research experience includes seven years of field and laboratory work on the effects of oil pollution and, later, the effects of logging on benthic invertebrates, eleven years of research on the ecology and behavior of Dungeness, king, and Tanner crabs in relation to the management of these species and three years of research on the impact of the *EXXON VALDEZ* oil spill on subtidal sediments within and outside Prince William Sound.

1983-1987: Affiliate Assistant Professor of Fisheries, School of Fisheries and Science, University of Alaska, Juneau.

Selected Publications:

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.

O'Clair, C.E., J.W. Short and S.D. Rice. 1993. Contamination of subtidal sediments by oil from the *EXXON VALDEZ* in Prince William Sound, Alaska. *Exxon Valdez* Oil Spill Symposium, February 2-5, 1993, Anchorage, AK. Program and Abstracts pp. 55-56.

O'Clair, C.E., J.W. Short and S.D. Rice. In prep. Petroleum hydrocarbon-induced injury to subtidal marine sediment resources. Available Auke Bay Lab., 11305 Glacier Highway, Juneau, AK 99801.

JOAN FORSHAUG BRADDOCK

Institute of Arctic Biology, University of Alaska Fairbanks, Fairbanks, Alaska 99775.

EDUCATION:

1989 Ph.D. Oceanography, University of Alaska; Dissertation Title: Competition between two aquatic microorganisms for oscillating concentrations of phosphorus.

1983 M.S. Microbial Physiology, University of Alaska/Michigan State University; Thesis Title: Iron-limited growth kinetics of *Thiobacillus ferrooxidans* isolated from arsenic mine drainage.

1977 B.S. Biological Sciences, University of Alaska, cum laude.

PROFESSIONAL EXPERIENCE:

1990-present	Assistant Professor of Microbiology, Institute of Arctic Biology, University of Alaska Fairbanks
1989-1990	Research Associate, Water Research Center, University of Alaska Fairbanks
1985-1989	Graduate Research Assistant, Water Research Center, University of Alaska Fairbanks
1984-1985	Research Associate, Water Research Center, University of Alaska Fairbanks
1983-1984	Agricultural Assistant, Agricultural Experiment Station, University of Alaska
1980-1983	Graduate Research Assistant, Institute of Water Resources, University of Alaska
1979-1980	Chemist, Syva Company, Cupertino, CA
1977-1978	Research Assistant, Inst. of Marine Science, University of Alaska
1976-1977	Microbiologist, U.S. Environmental Protection Agency, Fairbanks AK

PUBLICATIONS

Reviewed Papers

Braddock, J.F., J.E. Lindstrom, T.R. Yeager, B.T. Rasley, G. Winter and E.J. Brown. Response of microbial populations following the T/V *Exxon Valdez* oil spill. In prep.

Wolfe, D.A., M.J. Hameedi, J.A. Galt, G. Watabayashi, J.W. Short, C.E. O'Clair, S. Rice, J. Michel, J.R. Payne, J.F. Braddock, S. Hanna and D.M. Sale. Fate of the oil spilled from the *T/V Exxon Valdez* in Prince William Sound. In prep.

Braddock, J.F. and E.J. Brown. Phosphate uptake by the yeast, *Rhodotorula rubra,* and the green alga, *Selenastrum capricornutum* Printz, after phosphate additions to steady-state continuous cultures. Microbial Ecology. In Review.

Prince, R.C., J.R. Clark, J.E. Lindstrom, E.L. Butler, E.J. Brown, G. Winter, M.J. Grossman, P.R. Parrish, R.E. Bare, J.F. Braddock, W.G. Steinhauer, G.S. Douglas, J.M. Kennedy and P. Barter. Bioremediation of the *Exxon Valdez* oil spill: monitoring safety and efficacy in 1990. In Situ and On-Site Bioreclamation. In Review.

Lindstrom, J.E., R.C. Prince, J.R. Clark, M. Grossman, J.F. Braddock, T. Yeager, G. Winter and E.J. Brown. 1991. Microbial hydrocarbon degradation potentials and populations in fertilized shoreline sediments impacted by the *Exxon Valdez* oil spill. Appl. Environ. Microbiol. 57:2514-2522.

Brown, E.J. and J.F. Braddock. 1990. Sheen Screen: a miniaturized Most Probable Number technique for oil-degrading microorganisms. Appl. Environ. Microbiol. 56:3895-3896.

Luong, H.V., J.F. Braddock and E.J. Brown. 1984. Microbial leaching of arsenic from low-sulfide gold mine material. Geomicrobiol. J. 4:85-90.

Braddock, J.F., H.V. Luong and E.J. Brown. 1984. Growth kinetics of *Thiobacillus ferrooxidans* isolated from arsenic mine drainage. Appl. Environ. Microbiol. 48:48-55.

Brown, E.J., H.V. Luong and J.M. Forshaug. 1983. Geomicrobiology of arsenic associated with gold deposits in Alaska. p.570-580 In G. Rossi and A.E. Torma (ed.), Recent progress in biohydrometallurgy. Associazione Mineralia Sarda, 09016, Iglesia, Italy.

Brown, E.J., H.V. Luong and J.M. Forshaug. 1982. The occurrence of *Thiobacillus ferrooxidans* and arsenic on subarctic streams affected by gold mine drainage. Arctic. 35:417-421.

Related Reports

Braddock, J.F., B.T. Rasley, T.R. Yeager, J.E. Lindstrom and E.J. Brown. 1992. Hydrocarbon mineralization potentials and microbial populations in marine sediments following the *Exxon Valdez* oil spill. Final Report to Alaska Department of Environmental Conservation.

Braddock, J.F., J.E. Lindstrom and E.J. Brown. 1990. Microbial hydrocarbon degradation in sediments impacted by the *Exxon Valdez* oil spill. Final Report to Science Applications International Corporation for the National Oceanic and Atmospheric Administration, NOAA contract number 50-DSNC-8-00141.

AWARDS AND FELLOWSHIPS

Druska Carr Schaible Memorial Award (for outstanding Biological Sciences major), 1977; Graduate Resource Fellowship, 1981 and 1982.

PROFESSIONAL ORGANIZATIONS

American Society for Microbiology, American Society of Limnology and Oceanography, American Association for the Advancement of Science, Association for Women in Science, Sigma XI.

GRADUATE ADVISORY COMMITTEE CHAIR FOR:

Ph.D.: Jon Lindstrom, Biology; Richard Smith, Biochemistry and Molecular Biology
M.S.: Sharon Moore, Environmental Quality Science; Lee Nix, Environmental Quality Engineering
M.A.: Qiaofei Zheng, Chemistry

Personnel Qualifications

Stanley D. Rice
Principal Investigator, ABL Habitat Program Manager

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

Project Description: Subtidal Monitoring - 5 Parts: Sediment hydrocarbons, microbiology, eelgrass communities, rockfish monitoring; and nearshore and subtidal fish monitoring.

Budget Category	Approved 1-Oct-92 28-Feb-93	Proposed* 1-Mar-93 30-Sep-93	Total FY 93	** FY 94	FY 95	FY 96	FY 97	Sum FY 98 & Beyond
Personnel	$0.0	$271.2	$271.2	$301.0	$192.0			
Travel	$0.0	$22.7	$22.7	$21.0	$13.0			
Contractual	$0.0	$560.4	$560.4	$500.0	$140.0			
Commodities	$0.0	$57.5	$57.5	$52.0	$23.0			
Equipment	$0.0	$9.0	$9.0	$2.0	$0.0			
Capital Outlay	$0.0	$0.0	$0.0	$0.0	$0.0			
Sub-total	$0.0	$920.8	$920.8	$876.0	$368.0	$0.0	$0.0	$0.0
General Administration	$0.0	$80.0	$80.0	$80.2	$38.6			
Project Total	$0.0	$1,000.8	$1,000.8	$956.2	$406.6	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)	0.0	5.0	5.0					

Amounts are shown in thousands of dollars.

Budget Year Proposed Personnel:

Position	Months Budgeted	Cost	Comment
For detail, see 3A & 3B forms			

* FY 93 is a transition year from the previously used oil fiscal year to the federal fiscal year. This new project also includes proposed funding for January and February, 1993. ** Includes closeout funding at $217.6K.

Project Number: 93047
Project Title: Subtidal Monitoring (5 Parts)
Agencies: Nation ceanic & Atmospheric Admin.

FORM 2A PROJECT DETAIL

Project Description: Subtidal Monitoring, Part 1 - Documentation of levels and changes in levels of petroleum hydrocarbons in sediments in subtidal areas of Prince William Sound, Alaska.

Budget Category	Approved 1-Oct-92 28-Feb-93	Proposed* 1-Mar-93 30-Sep-93	Total FY 93	** FY 94	FY 95	FY 96	FY 97	Sum FY 98 & Beyond
Personnel	$0.0	$99.7	$99.7	$128.0	$62.0			
Travel	$0.0	$12.6	$12.6	$12.0	$7.0			
Contractual	$0.0	$160.0	$160.0	$210.0	$65.0			
Commodities	$0.0	$18.0	$18.0	$10.0	$2.0			
Equipment	$0.0	$9.0	$9.0	$2.0	$0.0			
Capital Outlay	$0.0	$0.0	$0.0	$0.0	$0.0			
Sub-total	$0.0	$299.3	$299.3	$362.0	$136.0	$0.0	$0.0	$0.0
General Administration	$0.0	$26.2	$26.2	$33.9	$13.9			
Project Total	$0.0	$325.5	$325.5	$395.9	$149.9	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)	0.0	1.9	1.9					

Amounts are shown in thousands of dollars.

Budget Year Proposed Personnel:

Position	Months Budgeted	Cost	Comment
P.I. Biologist GS12	3.0	$20.4	
Biologist GS9	9.0	$36.7	
Biologist GS9	9.0	$36.7	
NMFS Program Manager	1.2	$5.9	

* FY 93 is a transition year from the previously used oil fiscal year to the federal fiscal year. This new project also includes proposed funding for January and February, 1993. **FY94 includes closeout funding of $78.8K.

20-Aug-92

Project Number: 93047
Project Title: Subtidal Monitoring
Sub-Project: Part 1: Sediment Hydrocarbons
Agency: Nationa eanic & Atmospheric Admin.

FORM 3A SUB-PROJECT DETAIL

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		Proposed
Travel:	5 staff RT Juneau to Valdez and Prince William Sound 4 staff RT for intra and inter agency meetings and symposia.	$12.6
Contractual:	Vessel charters 20 days @ $3.5K/day ($70.0), hydrocarbon chemical (UV screening and chromatography/mass spectroscopy) analysis ($90.0).	$160.0
Commodities:	Sampling supplies (bottles, solvents, shipping containers $2.5), 3 dive suits ($4.0) dive tanks ($1.5), misc. dive supplies ($1.5), software upgrades ($2.0), field gear including boots, gloves, rain suits, mustang suits $3.0), publication costs ($1.0), office supplies ($1.5)	$18.0
Equipment:	Air compressor ($4.0), GPS unit ($3.0), printer ($2.0)	$9.0

Project Description: Subtidal Monitoring, Part 2 - Documentation of levels and changes in levels of microbiological populations in subtidal areas of Prince William Sound, Alaska.

Budget Category	Approved 1-Oct-92 28-Feb-93	Proposed* 1-Mar-93 30-Sep-93	Total FY 93	** FY 94	FY 95	FY 96	FY 97	Sum FY 98 & Beyond
Personnel	$0.0	$2.5	$2.5					
Travel	$0.0	$0.0	$0.0					
Contractual	$0.0	$62.4	$62.4					
Commodities	$0.0	$0.0	$0.0					
Equipment	$0.0	$0.0	$0.0					
Capital Outlay	$0.0	$0.0	$0.0					
Sub-total	$0.0	$64.9	$64.9	$0.0	$0.0	$0.0	$0.0	$0.0
General Administration	$0.0	$4.7	$4.7					
Project Total	$0.0	$69.6	$69.6	$0.0	$0.0	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)	0.0	0.1	0.1					

Amounts are shown in thousands of dollars.

Budget Year Proposed Personnel:

Position	Months Budgeted	Cost	Comment
Program Manager	0.5	$2.5	

* FY 93 is a transition year from the previously used oil fiscal year to the federal fiscal year. This new project also includes proposed funding for January and February, 1993.

20-Aug-92

Project Number: 93047
Project Title: Subtidal Monitoring
Sub-Project: Part 2: Microbiology
Agency: AK Dep f Environmental Conservation

FORM 3A SUB-PROJECT DETAIL

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		Proposed
Travel:		
Contractual:	Contract to University of Alaska, Fairbanks	$62.4
Commodities:		
Equipment:		

DRAFT

EXXON VALDEZ OIL SPILL RESTORATION SCIENCE PLAN

PROJECT TITLE: Subtidal Monitoring: Recovery of Sediments, Hydrocarbon Degrading Microorganisms, Eelgrass Communities, and Fish in the Shallow Subtidal Environment

PROJECT ID NUMBER: 93047, NOAA Component: Subtidal Fish

PROJECT TYPE: Fish

PROJECT LEADER: Usha Varanasi, Ph. D.

LEAD AGENCY: NOAA, NMFS
Northwest Fisheries Center
Environmental Conservation Division
2725 Montlake Blvd. East
Seattle, Washington 98112

COOPERATING AGENCIES: ADFG/UAF

PROJECT COST (NOAA): $190.2K (includes $25K for vessel support)

DATES OF THE STUDY: Start: April 1993. Finish: March 1994

GEOGRAPHIC AREA OF PROJECT: Prince William Sound

PROJECT LEADER SIGNATURE: Usha Varanasi

PROJECT MANAGER:

NAME: _____

SIGNATURE: _____

A. INTRODUCTION

Because petroleum and its components can cause damage to fishery resources, we plan to continue monitoring the recovery from oil exposure of the nearshore fisheries resources of Prince William Sound. Such monitoring will include measurement of petroleum exposure and short-term effects in several fish species, as was done under NRDA Projects F/S 24 and ST7 in the summer and fall of 1989 and the summers of 1990 and 1991 (Varanasi et al., 1990, 1991). In addition, we will continue to assess certain long-term biological effects, such as histopathological alterations of liver, gill, kidney, and gonad, as was done in the summer of 1990 and 1991. However, the scope of the proposed investigation is reduced substantially compared to the work done under F/S 24 in 1989 and 1990, in that the study area will be limited to Prince William Sound, and fewer fish species will be examined. We propose to continue only those portions of the previous NRDA studies which are most likely to assist in documentation of recovery from injury or damage.

Exposure of animals to crude oil can result in changes at the tissue and cellular levels (National Academy of Sciences, 1985). Examples of such changes after exposure of fish to oil-contaminated sediments include liver hypertrophy and fatty liver in winter flounder (Payne et al., 1988) and the occurrence of hepatocellular lipid vacuolization in English sole (McCain et al., 1978). Certain AHs (e.g., benzo[a]pyrene) are known carcinogens in rodents and fish (Lutz, 1979; Bailey et al., 1989), and studies with several bottomfish species show that, of the xenobiotic chemicals in sediments, AHs are most strongly associated with high prevalences of liver lesions, including neoplasms (Myers et al., 1987; Varanasi et al., 1987; Baumann, 1989). Generally, histopathological lesions of the types noted above do not become manifest until

several months or years after exposure (Schiewe et al. 1991). However, by the summer of 1993, fish in and around oil-impacted sites will have potentially been exposed to petroleum components for more than four years. Moreover, there are some published data which suggest that histopathological changes have occurred in some fish species as a result of exposure to oil spilled from the EXXON Valdez (Khan et al., 1990). Accordingly, assessment of histopathological effects in bottom fish species continues to be strongly warranted as these fish species contiure to show certain levels of exposure to spilled oil. Hence, this proposal includes monitoring of changes in the level of exposure and pathological alterations in selected fish species.

B. PROJECT DESCRIPTION

This project will monitor recovery of selected fish species by continuing to measure exposure to oil and oil components in fish of Prince William Sound. Additionally, we will continue to assess certain biological effects, such as histopathological alterations in these fish. Only by employing a broad spectrum of state-of-the art chemical, biochemical and biological methods will analytical data be obtained to document (1) the degree of exposure to petroleum hydrocarbons and natural recovery of affected species, and (2) the resultant biological effects of exposure to petroleum hydrocarbons on economically and ecologically important fish species. We will then incorporate this information for important Alaskan fish species into models for use in estimating oil spill impacts on fishery resources, as well as recovery from such oil exposures.

1. Objectives

   a. To sample selected fish species (e.g. yellowfin sole, rock sole, flathead sole) from several sites inside Prince William Sound. Site selection is primarily based on data from the last three years of sampling and analyses.

Representative sediment samples will also be taken from each benthic sampling site for subsequent chemical analysis.

b. To estimate the exposure to petroleum hydrocarbons by measuring levels of hydrocarbon metabolites in bile of the above species from oiled and nonoiled habitats such to detect statistically significant differences in bile concentrations with a = 0.05. Additionally, stomach contents of fish showing high levels of hydrocarbon metabolites in bile will be analyzed for hydrocarbons, such to detect significant differences in concentrations with a = 0.05.

c. To estimate the induction of hepatic aryl hydrocarbon hydroxylase activity or increased levels of cytochrome P-450IA in the above species from oiled and nonoiled habitats such to detect statistical differences in levels of effects with a = 0.05.

d. To estimate the prevalence of pathological conditions in the certain of the above species from oiled and nonoiled habitats such to detect statistical differences in levels of effects with a = 0.05.

e. To estimate temporal changes in the parameters described in Objectives b and c, by comparing data obtained in 1993 to data obtained in 1989, 1990, and 1991. In order to assess either rates of natural recovery or increased damage of habitats from the oil spill, trends in these parameters must be statistically significant at a = 0.05.

f. Using the above data, as appropriate, evaluate oil spill impacts on fishery resources for important Alaskan fish species. These evaluations will incorporate

pre-spill information from the fisheries literature on mortality and fecundity together with information on pathological conditions and biochemical effects in fish exposed to petroleum hydrocarbons as a result of the spill.

2. Methods

a. General Strategy and Approach

Samples of benthic fish (yellowfin sole, rock sole, flathead sole) will be collected from 10 sites during 1993. Oiled sites proposed for sampling are Snug Harbor, Sleepy Bay, Herring Bay, Northwest Bay and Bay of Isles. Control sites proposed for sampling are Olsen Bay , Drier Bay, Lower Herring Bay, Moose Lips Bay and Zaikof Bay.The sample locations are being coordinated with all other Subtidal Restoration Studies. The selection of species is based primarily on results obtained in 1991, 1990 and 1989 under NRDA Fish/Shellfish Study 24 and Subtidal Study 7. Surficial sediment samples for establishing levels of petroleum hydrocarbon residues will be collected at these sites.

Petroleum exposure of fish will primarily be assessed by measuring (a) concentrations of metabolites of aromatic petroleum compounds in bile, and (b) AHH activities in liver. These types of measurements are necessary because petroleum hydrocarbons in fish are rapidly metabolized to compounds that are not detectable by routine chemical analyses (Varanasi et al. 1989). The bile metabolite method has recently been validated for use in fish exposed to oil from the EVOS (Krahn et al., 1992). AHH activity in fish is due primarily to a single cytochrome P450, apparently cytochrome P450IA (Varanasi et al., 1986, Buhler and Williams 1989). Hepatic AHH activity should be a sensitive biomarker of contaminant exposure in sampled animals (Collier and Varanasi, 1991). Moreover, the induction of AHH activity indicates not only that contaminant exposure has occurred, but also that biological changes have occurred

as a result of the exposure. In addition to measuring AHH activity, cytochrome P450IA will be directly quantitated in selected liver or tissue samples by an immunochemical method recently developed at the University of Bergen (Goksøyr, 1991; Collier et al, 1992). Direct quantitation of cytochrome P450IA1 has the advantage that it can be used on archived samples and samples frozen at non-cryogenic temperatures (> -80° C). Using the immunochemical method removes the requirement for very low temperature preservation, and thus allows comparisons to be made between data collected in this Restoration Science Program and data from other sample collection programs which use immunochemical quantitation techniques.

Other biological effects in fish will be estimated by examining selected species for pathological conditions. Pathological conditions will include grossly visible abnormalities (e.g., fin erosion) and other lesions diagnosed by histological procedures (e.g., gill necrosis, liver cell necrosis).

Samples of sediment, and selected stomach contents of fish (from fish whose bile had evidence of oil exposure) will be analyzed for hydrocarbons by recently refined, scientifically sound and cost-effective analytical procedures involving high-performance liquid chromatography, gas chromatography and mass spectroscopy (Krahn et al., 1988, 1992).

Environmental damage and recovery will be assessed using statistical and simulation models, which will be developed as part of these proposed studies, as well as from other investigations with related fish species. The bile and tissue chemistry data, and histopathological data will be used to establish relationships between biological damage and estimated exposures to petroleum hydrocarbons.

b. Sampling Methods

Sampling activities will be conducted in June/July 1993 at 5 sites in Prince William Sound, including oiled and control sites [Olsen Bay (Port Gravina), Rocky Bay (Montague Island), Snug Harbor (Knight Island), Sleepy Bay (Latouche Island), and Squirrel Bay (Evans Island)]. Sample collection will be performed from a charter vessel, at water depths of between 5 to 100 meters. At each site, sediment samples will be collected with a box corer, VanVeen or Smith-McIntyre grab. Sediments will be stored at - 20°C. The coordinates and depths of each station will be recorded.

Fish will be collected primarily with a bottom trawl, performed with an otter trawl (7.5 m opening, 10.8 m total length, 3.8 cm-mesh in the body of the net, and 0.64 cm-mesh in the liner of the cod end). Tows will be of 5 to 15 minutes duration. Other fish sampling gear appropriate to the species and conditions will also be deployed. Individuals of selected target fish species will be sorted and examined for externally visible lesions; up to 30 fish of selected species will be measured, weighed, and necropsied; and tissue samples will be excised and preserved in fixative for histopathological examination or frozen for chemical analyses.

Chain of custody prodedures will be followed after collection of all samples. Samples for chemical analyses will be stored frozen for at least three years, or until disposal is authorized by the Trustees.

c. Standard Operating Procedures for Laboratory Analyses

(1) Bile Metabolite Assay. Samples of bile will be injected directly into a liquid chromatograph and a gradient elution conducted using a Perkin-Elmer HC-ODS with a gradient of 100% water (containing 5µL acetic acid/L) to 100% methanol (Krahn et al., 1984, 1986a, b, c). Two fluorescence detectors are used in series. The

excitation/emission wavelengths of one detector are set to 290/335 nm, where metabolites of naphthalene (NPH) fluoresce. Excitation/emission wavelengths of the other detector are set to 260/380 nm, where metabolites of phenanthrene (PHN) fluoresce. The total integrated area for each detector is then converted (normalized) to units of either NPH or PHN that would be necessary to give that integrated area.

(2) Liver Aryl Hydrocarbon Hydroxylase (AHH) Activity and Cytochrome P-450IA Analysis. Hepatic microsomes are prepared essentially as described by Collier et al. (1986) and microsomal protein is measured by the method of Lowry et al. (1951), using bovine serum albumin as the standard. AHH activity is assayed by a modification of the method of Van Cantfort et al. (1977) as described by Collier et al. (1986), using ^{14}C-labeled benzo[a]pyrene as the primary substrate. All enzyme assays will be run under conditions in which the reaction rates are in the linear range for both time and protein. Cytochrome P-450IA will be measured by an ELISA utilizing rabbit antibodies to cytochrome P-450c isolated from Atlantic cod (Goksøyr,1991).

(3) Histopathology. Histopathological procedures to be followed are described in the report from the Histopathology Technical Group for Oil Spill Assessment Studies in Prince William Sound, Alaska. Briefly, the procedures will involve the following: (a) tissues preserved in the field will be routinely embedded in paraffin and sectioned at five microns (Preece, 1972); and (b) paraffin sections will be routinely stained with Mayer's hematoxylin and eosin, and for further characterization of specific lesions, additional sections will be stained using standard special staining methods (Thompson, 1966; Preece, 1972; and Armed Forces Institute of Pathology, 1968). All slides will be examined microscopically without knowledge of where the fish were captured. Hepatic lesions will be classified according to the previously

described diagnostic criteria of Myers et al. (1987). Ovarian lesions will be classified as described in Johnson et al. (1988).

e. Data Analysis

Where possible, non-parametric statistical tests will be employed to avoid assumptions that the data are normally distributed. Non-parametric tests give highly reliable results. The principal non-parametric tests that will be used are Spearman rank correlation, which has about 91% of the power of product-moment correlation when the parametric assumptions are met (Zar, 1984), and the heterogeneity-G statistic. Spearman rank correlation will be used for estimating uptake and metabolism of petroleum hydrocarbons from oiled and non-oiled habitats when an independent measure of contamination (e.g., levels of AHs in sediment) is available.

The heterogeneity-G statistic (Sokal and Rohlf, 1981) will be used to study prevalence of pathological conditions at oiled and non-oiled habitats. In addition, logistic regression (appropriate where the outcome variable is binomial) will be used to model the prevalences of pathological conditions in relation to contamination.

The Kruskal-Wallis test (a non-parametric form of ANOVA) will be used for supporting statistical analyses of variation in sediment PAH levels at sites sampled. If the null hypothesis of no differences among sites is rejected at $a = 0.05$, a non-parametric multiple comparison test (Dunn, 1964; Hollander and Wolfe, 1973; Zar, 1984) will be used to determine differences between sites at $a = 0.05$. Principal components analysis and LOWESS (Chambers et al., 1983) will also be employed for this purpose; both are methods of exploratory data analysis rather than inferential statistical methods.

Cohen (1977) will be used for computations of statistical power.

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C. SCHEDULES AND PLANNING

1. Work Schedule (See milestone chart below)

	1993									1994	
	M	A	M	J	J	A	S	O	N	D	J	F
Collect samples				X	X							
Analyses of bile for metabolites					X	X	X	X	X	X		
Analyses of liver for AHH activity and P-450					X	X	X	X	X	X		
Histopathological analyses					X	X	X	X	X	X		
Analyses of sediments and stomach contents					X	X	X	X	X	X		
Submission of report												X

2. Project Personnel.

The proposed project will be managed by the Project Leader, Dr. Usha Varanasi (Director, Environmental Conservation Division, NWAFC). Several Co - Project Leaders will also be involved: Dr. Sin-Lam Chan (Deputy Division Director) and Dr. Cheryl A. Krone will coordinate the project; Dr. Margaret Krahn will supervise and perform the chemical analyses of bile; Dr. Tracy Collier will supervise analyses for enzyme activities and cytochrome P450IA; Mr. Mark Myers will supervise and perform the effects studies concerned with histopathological conditions; Mr. William Gronlund will supervise the collection of samples in the field; and Dr. John Landahl will supervise and perform data management and statistical testing operations.

2. Logistics

It is anticipated that a total of about 20 days will be needed to perform necessary field work. Sites are as designated in sampling methods. Planning for conducting field sampling is being coordinated with other Subtidal Restoration projects.

D. ENVIRONMENTAL COMPLIANCE

It is not anticipated that this study will have a significant effect on the environment and an Environmental Impact Statement or Environmental Assessment will not be necessary. No mammals or birds will be captured during the course of the proposed study.

E. PERFORMANCE MONITORING

1. Management Plan

See Section C. for a description of the chain-of-command and duties of key project personnel. The Environmental Concervation Division employs a large pool of trained scientists capable of completing the project if personnel changes occur.

2. Quality Assurance and Control Plans

a. Bile Analytes. Quality assurance procedures for bile analyses will include NPH and PHN calibration standards and the calibration standard will be analyzed after every 6 samples and the RSD will be reported. In addition, one blank sample and one reference material (control material) will be analyzed daily. The concentrations of analytes should be within 2 SD of the established concentrations in control material. Replicate analyses will be performed on 10% of the samples, if a sufficient amount exists.

b. AHH Activity and Cytochrome P-450IA. Quality assurance procedures for AHH measurements include duplicate zero-time and boiled enzyme blanks for each set of assays. Each sample will be run in duplicate and those samples showing > 20% absolute difference between duplicates and >10 units (pmoles benzo[a]pyrene metabolized/mg microsomal protein/minute) difference between duplicates will be repeated. ELISAs for cytochrome P-450IA will be run in triplicate, and if the resulting coefficient of variation (CV) is > 10%, the outlying replicate will be omitted from the calculations. If the CV still exceeds 10%, the analysis of that sample will be repeated.

c. Histopathology. Pathologists on this project will use consistent, standard diagnostic criteria to be strictly adhered to by those who will also be examining slides in this project. These criteria will be established using color photographs of external lesions and standard reference slides containing tissues with the major lesion types

expected in the study. Unusual or atypical lesions will be referred to specialists for confirmation. The accuracy of the histopathologic diagnosis also will be assured by consulting with and sending sections of tissues with representative lesion types to the Registry of Tumors in Lower Animals, National Museum of Natural History at the Smithsonian Institution in Washington, D.C.

f. Products

Status reports will contain information on the distribution and concentrations of petroleum hydrocarbons and their metabolites in fish tissues and in sediments obtained from sites in Alaska; the hepatic activities of AHH and levels of cytochrome P-450IA in fish from sites in Alaska; and the distribution and prevalence of histopathological disorders among selected species from those sites. Chemistry data will be submitted in the form of data tables and distribution maps, and all data will be stored in computerized data management programs. Fish pathology data will be reported in the form of distribution maps, tables describing disease frequencies of each species examined, photographs of gross and microscopic properties of abnormalities, figures representing various types of biological data (e.g., length-weight, age-weight) and discussions of the relative importance of the types of abnormalities found. Comparisons of the characteristics of these abnormalities will be made with similar conditions previously reported in other marine areas of the world. The data management formats were designed in cooperation with the National Oceanographic Data Center (NODC), and are compatible with the NODC data storage systems. In addition, articles describing the results of these studies will be published in peer-reviewed scientific journals.

F. Personnel Qualifications

See attached curriculum vitae.

BIOGRAPHICAL SKETCH USHA VARANASI

Education

Bombay University, India	- B.S.	1961	Chemistry/Physics
California Institute of Technology, CA	- M.S.	1964	Organic Chemistry
University of Washington, Seattle, WA	- Ph.D.	1968 Chemistry	Physical Organic

Research and Professional Experience

Past

1969-1971	**Research Associate,** Oceanic Institute of Honolulu, HI
1971-1974	**Associate Research Professor** (Chemistry), Seattle University (SU), Seattle, WA
1975-1980	**Research Chemist,** National Marine Fisheries Service (NMFS), Seattle, WA
1980-1986	**Affiliate Associate Professor** (Chemistry) University of Washington (UW), Seattle, WA
1980-1987	**Editorial Board Member,** *Aquatic Toxicology*
1981-1987	**Supervisory Research Chemist, and Manager of Biochemistry Program,** NMFS, Seattle, WA
1986	**Scientific Program Chair:** International Symposium on "Toxic Chemicals and Aquatic Life:Science & Management"
1987-1990	**Member, Board of Directors,** Society of Environmental Toxicology and Chemistry
1987-1990	**Member, Steering Committee,** Puget Sound Water Quality Authority
1989	**Editor**: Metabolism of Polycyclic Aromatic Hydrocarbons in the Aquatic Environment, (Published by The CRC Press, 1989)

Current

1987-present	**Director,** Environmental Conservation Division, NMFS
1975-present	**Research Professor** (Chemistry), SU, Seattle, WA
1980-present	**Advisor**, NRC-NOAA Research Associateship Program
1986-present	**Affiliate Professor** (Chemistry), UW Seattle, WA
1989-present	**Chair**, Marine Mammal Tissue Bank Experts Committee
1990-present	**Member**, Puget Sound Estuary Program (PSEP) Management Committee
1990-present	**Advisory Board Member**, Institute of Wildlife and Environmental Toxicology, Clemson University
1988-1992	**Board Member**, Southern California Coastal Water Research Project
1988-1991	**Chair**, Publications Committee, Society of Environmental Toxicology and Chemistry
1987-1991	**Member, Board of Directors**, Society for Environmental Toxicology and Chemistry
1991	**Member**, Expert Panel for Reauthorization of Clean Water Act

Honors

1961 - 1963	California Institute of Technology Scholarship
1977,1981,1982	Outstanding Performance Award, NMFS, NOAA
1981	**Outstanding Employee of the Year** for the National Marine Fisheries Service
1988, 1991	**Unusually Outstanding Performance Awards** for the National Marine Fisheries Service

Selected Recent Publications (total - over 100)

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BIOGRAPHICAL SKETCH SIN-LAM CHAN

Education

University of Singapore	- BSc Honors	1963	Biochemistry
McGill University, Canada	- Ph.D.	1968	Biochemistry
University of B.C., Canada	- Post Ph.D. Fellow	1968	Neurochemistry
University of California San Francisco, CA	- Post Ph.D. Fellow	1969-1971	Interdisciplinary (Pharmacol./Toxicol.)

Research and Professional Experience

1971-1976	**Assistant Research Pharmacologist/Assistant Research Professor,** University of California, San Francisco
1976-1977	**Toxicologist,** Toxicology Branch, Office of Pesticide Program, EPA
1977-1979	**Principal Toxicologist,** Toxicology Branch, Office of Pesticide Program, EPA
1979	**Section Chief,** Supervisory Toxicologist/Pharmacologist, Toxicology Branch, Hazard Evaluation Division, Office of Pesticide Program, EPA
1979-present	**Deputy Director,** Environmental Conservation Division, NWFC, NMFS, NOAA

Honors

1962	Cambridge Scholar (equivalent to Gold Medal Award)
1962	Book Prize for Biochemistry
1963-1967	Canadian Commonwealth Scholar
1979	EPA Superior Performance Award
1981	NMFS/NOAA Superior Performance Award
1990	Dept. of Commerce Unit Citation

Selected Publications (total - over 30)

Chan, S-L. and J.H. Quastel. (1967). Tetrodotoxin: Effects on brain metabolism *in vitro*. *Science*, 156:1752.

Chan, S-L. and J.H. Quastel. (1970). Effects of neurotropic drugs on Na+ influx into rat brain cortex in vitro. *Biochem. Pharmacol.* 9:1071.

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McCain, B.B, D.C. Malins, M.M.Krahn, D.W. Brown, W.D. Gronlund, L.K. Moore and **S-L. Chan.** (1990). Uptake of aromatic and chlorinated hydrocarbons by juvenile chinook salmon (*Oncorhynchus tshawystscha*) in an urban estuary. *Archives of Env. Contamination and Toxicology*, 19:10-16.

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Krahn, M.M., G.M. Ylitalo, J. Joss and **S-L. Chan** (1991). Rapid, semiquantitative screening of sediments for aromatic compounds using sonic extraction and HPLC/fluorescence analysis. *Mar. Environ. Res.* (in press).

BIOGRAPHICAL SKETCH MARGARET M. KRAHN

Education

Univ. of Minnesota	B.Chem. (with honors)	1964	Chemistry
Univ. of Washington	Ph.D.	1968	Organic Chemistry

Research and Professional Experience

1978-present	Research Chemist, NOAA National Analytical Facility
1978-79	Instructor of Chemistry, Seattle Central Community College (part time).
1972-1978	Assistant/Associate Professor of Chemistry, University of Delaware

Honors

1982	Department of Commerce Sustained Superior Performance Award
1981	Department of Commerce Outstanding Performance Award
1979	Department of Commerce Unit Citation
1964-1967	National Science Foundation Fellow

Selected Publications (total - 32)

Krahn, M.M., G.M. Ylitalo, J. Joss and S-L. Chan. 1991. Rapid, semiquantitative screening of sediments for aromatic compounds using sonic extraction and HPLC/fluorescence analysis. *Mar. Environ. Res.* (in press).

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BIOGRAPHICAL SKETCH **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

1972-1976	**Biological Aid/Physical Science Technician,** ECD, NMFS
1976-1978	**Fishery Biologist**, ECD, NMFS
1978-1992	**Research Chemist**, ECD, NMFS
1988-1992	**Assistant Task Manager**, Biochemistry Task of the Environmental Conservation Division, NMFS
1989-present	**Co-principal Investigator** on Projects funded by Ocean Assessment Division, NOAA, and Natural Resources Damage Assessment after the EXXON Valdez oil spill
1990-present	**Division Coordinator** of efforts involving Natural Resources Damage Assessment and Natural Resources Restoration after the EXXON Valdez oil spill
1991	**Chief Scientist**, Natural Resources Damage Assessment survey of Prince William Sound
1992-present	**Supervisory Research Chemist**, ECD, NMFS
1992-present	**Assistant Program Manager**, Ecotoxicology Program of the ECD, NMFS

Honors

1972	National Merit Scholar
1984	Elected to Society of the Sigma Xi
1986	Best Student Platform Presentation, PANWAT Annual Meeting
1984, 1990	Outstanding Performance Award, NMFS, NOAA
1987, 1991	Sustained Superior Performance Award, NMFS, NOAA
1992	Gordon Conference participant, Drug Metabolism

Selected Publications (over 40 total)

Collier, T.K., M.M. Krahn, C.A. Krone, L.L. Johnson, M.S. Myers, S.-L. Chan, and U. Varanasi. (1993). Oil exposure and effects in subtidal fish following the EXXON Valdez oil spill. Proceedings 1993 International Oil Spill conference (in press).

Collier, T.K., J.E. Stein, A. Goksøyr, M.S. Myers, J.W. Gooch, R.J. Huggett, and U.Varanasi. (1993). Biomarkers of PAH exposure and effects in oyster toadfish (*Opsanis tau*) from the Elizabeth River, Virginia. *Environ. Sci.* (in press)

Johnson, L.L., J.E. Stein, **T.K. Collier**, E. Casillas, and U. Varanasi. (1993). Ovarian development, plasma estradiol concentrations, egg weight and fecundity in winter flounder (*Pseudopleuronectes americanus*) from urban and nonurban estuaries on the northeast Atlantic coast. *Sci Total Environm.* (in press).

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Johnson, L.L., J.E. Stein, **T.K. Collier**, E. Casillas, B. McCain, and U. Varanasi (1992). Bioindicators of contaminant exposure, liver pathology, and reproductive development in prespawning female winter flounder (*Pleuronectes americanus*) from urban and nonurban estuaries on the Northeast Atlantic coast. NOAA Technical Memorandum NMFS-NWFSC-1, 76 p.

Krahn, M.M., D.G. Burrows, G.M. Ylitalo, D.W. Brown, C.A. Wigren, **T.K. Collier**, S.-L. Chan, and U. Varanasi. (1992). Mass spectrometric analysis for aromatic compounds in bile of fish sampled after the *EXXON Valdez* oil spill. *Environ. Sci. Technol.* 26:116-126.

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BIOGRAPHICAL SKETCH **MARK S. MYERS**

Education

Swarthmore College, Swarthmore PA	-B.A.	1973	Biology/Zoology
University of Washington, Seattle WA	-M.S.	1981	Fisheries/Pathology

Research and Professional Experience

1975-1976 **Staff Research Associate**, Dept. of Pathology, Univ. CA, Davis

1976-1978 **Fisheries Biologist/Pathologist**, National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Seattle WA

6/78-12/78 **Predoctoral Research Assistant**, Regional Primate Research Center, University of Washington, Seattle WA.

1979-1980 **Research Exchangee,** Anokhin Institute of Physiology, Moscow, USSR, bilateral health research agreement between the US and USSR

1980-1987 **Fisheries Biologist/Pathologist, Research**, National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Seattle WA.

1987-present **Supv. Fisheries Biologist/Pathologist, Research**, Pathology Subtask Leader, National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Seattle WA.

Honors

1982	Sustained Superior Performance Award, NMFS, NOAA
1983	Outstanding Performance Award, NMFS, NOAA
1985, 1986	Sustained Superior Performance Award, NMFS, NOAA
1990	Sustained Superior Performance Award, NMFS, NOAA

Selected Publications (total - 44)

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BIOGRAPHICAL SKETCH **WILLIAM D. GRONLUND**

Education

University of Washington	-BS	1964
University of Washington	-M.S.	1969
University of Washington		1971-1976

Experience

1962-1965 BCF - Fisheries Aid. Studies of life history of salmonid fishes, primarily freshwater phases. Studies of fish passage and fishway engineering

1965-1968 BCF - Fishery Biologist. Studies on physiology of stress related to capture and handling of fish

1968-1971 BCF - Fishery Research Biologist. Studies on reproductive physiology and endocrinology of fishes. Work bioassay and characterization of hormones

1971-present NMFS-BCF, Fisheries Research Biologist. Studies of fish disease, immunology, and pollutant effects

Publications

Gronlund, W.D., S-L. Chan, B.B. McCain, R.C. Clark, Jr., M.S. Myers, P.D. Plesha, J.E. Stein, D.W. Brown, J.T. Landahl, M.M. Krahn, W.L. Reichert and U. Varanasi. 1991. Multidisciplinary assessment of pollution in Long Island Sound. Estuarine Res. Fed. (in press)

BIOGRAPHICAL SKETCH JOHN LANDAHL

Education

Cornell University, NY	- B.S.	1968	Biological Sciences
University of Washington, WA	- M.S.	1973	Zoology
University of Washington, WA	- Ph.D.	1985	Zoology

Research and Professional Experience

1969-1970	**Research Assistant**, The Pathfinder Fund, Chesnut Hill, MA
1975	**Research Assistant**, Friday Harbor Laboratories, University of Washington, Friday Harbor, WA
1976	**Consultant**, Seattle Public Aquarium, Seattle, WA
1979-present	**Physiologist**, National Marine Fisheries Service

Honors

Deep Springs Scholarships	1964-1966
Telluride Association Scholarships	1966-1968
Research Fellowship, Friday Harbor Laboratories, University of Washington, Friday Harbor, WA	1974

Selected Publications

Landahl, J. T., and R. B. Root. (1969). Differences in the life tables of tropical and temperate milkweed bugs, genus *Oncopeltus* (Hemiptera: Lygiadae). Ecology 50: 734-737.

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BIOGRAPHICAL SKETCH CHERYL A. KRONE

Education

University of Washington	-B.S.	1978	Human Nutrition
University of Washington	-M.S.	1981	Food Science
University of Washington	-Ph.D.	1984	Food Science

Research and Professional Experience

1984-present	**Research Chemist,** analytical chemistry , NOAA, NWAFC, Environmental Conservation Division
1983-1984	**Lecturer,** food chemistry and analysis, University of Washington
1979-1983	**Research Assistant,** School of Fisheries, University of Washington

Honors

1978	Phi Beta Kappa, University of Washington Chapter
1981, 1983	Egdtvedt Food Science Scholarship
1985, 1990	Department of Commerce Certificate of Recognition

Selected Publications (total - 19)

Krone, CA, J. E. Stein and U. Varanasi (1992). Estimation of levels of metabolites of aromatic hydrocarbons in fish tissues by HPLC/fluorescence analysis. *Chemosphere 24;* 497-510.

Krone, C.A., S-L. Chan and U. Varanasi (1991). Butyltins in sediments and benthic fish tissues from the east, Gulf and Pacific coasts of the United States. In: Oceans '91 Conference Proceedings Vol. 2. New York, New York, IEEE, p.1054-1059.

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G. Budget

Salaries	125.0K
Travel	7.2K
Supplies	33.0K
Contractual (Vessel support)	25.0K
	190.2K

Detailed Budget - Subtidal Monitoring Project #93047					
Salaries					
	Titles	**Grades**	**FTE**	**Cost**	
	Principal Investigator	GM-15	0.1	7.9	
	Res. Chemist	GM-13	0.2	11.5	
	Supv. Res. Chemist	GS-12	0.35	15.9	
	Fish. Biol. (Res.)	GS-11	0.4	15.1	
	Computer Specialist	GS-7	0.5	11.0	
	Fishery Biologist	GS-13	0.4	18.0	
	Biotechnician	GS-7	0.5	10.9	
Leave Surcharge				16.0	
Total Salaries					**106.2**
Employee Benefits					**18.8**
				total salaries	**125.0**
Travel					
4 RT to Anchorage for sampling @ $900				3.6	
(airfare $450/perdiem @ $225)					
3 RT to Anchorage for meetings @ $1200				3.6	
(airfare $450/perdiem @ $225)					
Total Travel					**7.2**
Contracts					
vessel charter, 20 days @ 1.25K/day					**25.0**
Supplies					
Office supplies				2.0	
Field sampling supplies				10.0	
chemicals, equipment maintenance and parts				21.0	
					33.0
PROJECT TOTAL					**190.2**

Subtidal Monitoring - Subtidal Fish				
		Contractual and Commodities		
Contractual			25.0	
Vessel charter 20 days @ $1.25 k/day)				
		total		**25.0**
Commodities				
Office supplies			2.0	**2.0**
Field Sampling				
disposable supplies (liquid nitrogen, ice, shipping containers, etc			6.0	
sampling equipment (including nets, doors, bridles, etc.)			4.0	
		subtotal	10.0	**10.0**
Chemical/Biochemical/Histopathological Analyses				
solvents, chemicals, etc.			8.0	
disposable supplies and glassware			4.0	
instrument maintenance, parts and service			9.0	
(includes HPLC columns,microscope cleaning,				
and tissue processor services)				
		subtotal	21.0	**21.0**
		total commodities	33.0	
		Grand total		**58.0**

DETAILED RESTORATION PROJECT DESCRIPTION

Project Title:	Subtidal Monitoring
Sub-Project:	Part 3: Eelgrass Communities
Project ID #:	93047
Project Leader:	Stephen C. Jewett
Lead Agency:	Alaska Department of Fish & Game
Cooperating Agencies:	National Oceanic & Atmospheric Administration, Alaska Department of Environmental Conservation, University of Alaska Fairbanks
Project Cost:	$254,200
Start Date:	March 1, 1993
Finish Date:	September 30, 1993
Geographic Area of Project:	Western Prince William Sound
Project Leader Signature:	
Project Manager:	
Name:	Dr. Joseph Sullivan, ADF&G
Signature:	

A. Introduction

This is an extension of the EXXON VALDEZ Oil Spill (EVOS) project that originated under COASTAL HABITAT (Subtidal Study No. 1) in 1989-90 and continued under AIR/WATER (Study ST2A: Injury to Benthic Communities - Shallow Benthos) in 1991.

Background on the Resource

The shallow subtidal habitat of Prince William Sound (PWS), from the intertidal zone to depths of approximately 20 m, typically has dense macrophyte (algal) assemblages. It is critical habitat for many commercially and ecologically important animals. The region is most noted as a nursery for salmon, king crab, Dungeness crab, and some pandalid shrimps, the spawning grounds for Pacific herring, and feeding grounds for sea otters, river otters and many marine birds. As primary producers, the benthic marine macrophytes are probably at least as important as the transient phytoplankton blooms. Seaweeds are used as a main food source for several marine invertebrates, including commercially important sea urchins. Subtidal eelgrass and intertidal beds, are extremely important feeding grounds for migratory waterfowl. Many of the algal aggregations contain large numbers of small, primary settling mussels. These shallow subtidal regions typically contain many polychaete worms, small snails and clams, amphipods, copepods, isopods, sea urchins, and sea stars. Many of these invertebrates serve as food for coastal-feeding otters, birds, fishes, crabs and shrimps.

Summary of Injury

Analyses of the 1990 and 1991 field data suggested that the effects of the EVOS on shallow (< 20 m) subtidal communities were most pronounced in areas of soft substrate in protected embayments (Jewett *et al.*, 1993). Effects on subtidal communities were also observed within other habitats. These included protected rocky reefs dominated by the smaller kelps (*Laminaria sacharrina* and *Agarum cribosum*) and more exposed reefs dominated by the bull kelp, *Nereocystis*.

The dominant plant of soft-bottom habitats is eelgrass (*Zostera marina*). It generally occurs within a depth range of < 3 meters. Attached to the eelgrass are a variety of small sessile invertebrates including the small mussel, *Musculus* spp. Fish (mostly juvenile Pacific cod *Gadus macrocephalus*) and larger epibenthic invertebrates (e.g., the leather star *Dermasterias imbricata, the* sunflower sea star *Pycnopodia helianthoides*, and the helmet crab *Telmessus cheiragonus*) live in association with the eelgrass and feed on the infauna and epifauna within the eelgrass habitat. The largely unvegetated sand or mud bottom extending beyond the eelgrass is rich in infauna and epifauna (e.g., polychaetes, bivalves, gastropods, and amphipods) that are food to a variety of fishes, marine birds, and sea and river otters.

Almost all components of the eelgrass habitat were affected by the EVOS. This was seen in the first survey in the summer of 1990. The health of the benthic community at 3-20 m depths, outside the eelgrass bed, was generally less robust at oiled sites than at control sites. The oiled sites had significantly less total invertebrate abundance, as well as several dominant invertebrate taxa having less abundance and/or biomass. These included several families of clams that are important food for sea otters. Another group that was less prevalent at oiled sites was the oil-sensitive benthic amphipods.

Contrary to the findings beyond the eelgrass bed, the benthic community within the bed in 1990 was somewhat enhanced at oiled sites. The greater total invertebrate abundance and biomass at the oiled sites were primarily attributable to small epifauna attached to the eelgrass blades. In particular, there were high abundances of the suspension-feeding spirorbid polychaetes and mytilid mussels (*Musculus*), as well as the predator/scavenger lacunid snails and onchidorid nudibranchs. Juvenile and adult Pacific cod were also more abundant at oiled sites. However, eelgrass turions and flowers, benthic amphipods, and helmet crabs (*Telmessus*) were less prevalent at oiled sites.

The data collected in 1991 suggest partial recovery. Analyses of data collected from the most recent survey in the summer of 1991 showed more robust communities outside the eelgrass bed than in 1990. For example, in 1991 there was no difference in total invertebrate abundance between oiled and control sites. Perhaps the greatest single indication of recovery was observed with oil-sensitive benthic amphipods; there were no differences between oiled and control treatment groups in 1991. Several other dominant taxa, less prevalent at oiled sites in 1990, showed no difference between treatment groups in 1991. However, a dominant polychaete family and a snail family still were less prevalent at deep oiled sites than control sites, suggesting that recovery is not yet complete.

The enhanced appearance observed at oiled sites in the eelgrass bed in 1990 was not evident in 1991. No differences are now evident in eelgrass turions or flowers, benthic amphipods, and helmet crabs. However, several dominant invertebrate taxa had lower abundance or biomass at oiled bed sites in 1991. These included two worm families and two snail families, besides the leather sea star, *Dermasterias*. Juvenile Pacific cod were still more abundant at oiled sites in 1991. Therefore, recovery within the eelgrass bed in 1991 lagged substantially when compared to the benthic community beyond the eelgrass bed.

Most of the observed differences among oiled and control sites appear related to oiling or cleanup activities. Analyses of hydrocarbon data collectively revealed higher concentrations in the sediments from oiled sites than from control sites. Furthermore, the concentrations were generally higher in 1990 than in 1991.

Although no sampling occurred in 1992, most components of the benthic environment should have passed through the toxic phase of the EVOS. It is reasonable to assume that recovery is well underway, including within the eelgrass bed.

Earlier studies (e.g., McConnaughey, 1978; Calkins, 1978; Shaw and Hameedi, 1988; Faro *et al.*, 1993), and our own work as well, suggest that several of the effected species are important links to higher trophic levels. For example, benthic amphipods are important prey to a variety of sea birds and fishes, including Pacific halibut *Hippoglossus stenolepis*. The crab *Telmessus* feeds on eelgrass, *Musculus* mussels, and other epiphytes on eelgrass. *Telmessus,* in turn, serves as prey for a variety of vertebrates, including sea otters, river otters, and birds. In addition, *Musculus* is a primary component of the diet of juvenile cod that are abundant in the eelgrass habitat. As noted earlier, some infaunal bivalves are important food for sea otters.

B. Project Description

Resources and/or Services

The main focus of the 1993 monitoring efforts is on the eelgrass habitat for several reasons. First, the impacts to populations in habitats other than eelgrass seem to have been short lived. For example, algal populations apparently reduced by the spill began to recover almost immediately after the spill. They were almost fully recovered by 1990. Second, many impacts observed in the other habitats were similar to, but often less severe, than those observed in the eelgrass habitat. Because of the similarity of many of the observed effects, a signal of natural restoration in the eelgrass should also signal natural restoration in other habitats.

No specific restoration actions are intended during this phase of the project. However, some restoration activity may be identified after the 1993 monitoring effort. Complete restoration or recovery implies a return to prior abundance levels and a return to ecological pathways within the community as well. This may have taken years to develop. These ecological pathways involve a range and magnitude of biological, chemical, and physical mechanisms with synergistic effects which are little understood. These pathways are believed to be essential to the stability of the community. Drastic changes induced by the EVOS undoubtedly altered these pathways. The resulting community may never return to its prespill structure and internal integrity, although abundances may return to prespill levels.

The planned approach for 1993 is to monitor the various stages of succession toward stabilization in the eelgrass community by comparing components of oiled and unoiled sites. The same sites that were sampled in 1990 and 1991 are to be sampled again, including three of the five pairs of oiled and control eelgrass sites that were sampled in 1991. Methods will be the same as was used in 1990 and 1991. Abundances of eelgrass, infauna, amphipods, small epifauna attached to eelgrass, large epifauna (i.e., crabs and sea stars), and juvenile Pacific cod will be determined. In addition, some manipulative experiments are to be conducted on selected key species.

Objectives

The general objective is to monitor the natural recovery of the shallow (< 20 m) subtidal eelgrass community in Prince William Sound that was impacted by the EVOS. Primary objectives are to: 1) spatially compare richness, diversity, abundance and biomass of dominant taxa between paired (oiled vs control) sites; and 2) temporally compare these population parameters. Secondary objectives are to: 1) examine the effect of the helmet crab *Telmessus* on *Musculus* mussels and eelgrass abundance; and 2) examine the effect of *Musculus* on eelgrass abundance and flower production.

Methods

1. Stratified Sampling - Rationale

A stratified sampling design, modified from the design used in our 1990 and 1991 surveys, will be employed. Its purpose is to obtain estimates of basic population parameters

(abundance and biomass) for infaunal invertebrates. These estimates will be used to show the effects of the EVOS on this community by comparing abundance (and other parameters) at oiled vs control sites. These data will also be used to support other studies (e.g., otters and birds) since the animals within the subtidal habitats are major food items for these other species.

2. Sampling within the Eelgrass Habitat

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

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

Sampling for eelgrass and fishes (within the eelgrass bed only) will follow the procedures previously used. The detailed Standard Operating Procedure for sampling within the eelgrass habitat is presented in Jewett *et al* (1993).

3. Experiment 1

This experiment is designed to examine the effect of *Telmessus* on *Musculus* and on eelgrass. Ten 2-m^2 plots will be established within the easternmost portion of the eelgrass bed at Sleepy Bay (a site where both *Telmessus* and *Musculus* are moderately abundant). The abundance of eelgrass and *Musculus* will be estimated within each plot by counting the number of eelgrass turions and collecting five turions from each plot and counting the number of attached *Musculus*. Each plot will be enclosed with a 1-inch mesh hoop net that extends from the bottom and is supported by floats at the surface. A single *Telmessus* is to be added to each of five randomly selected plots. The remaining five will have no *Telmessus*. After 10 to 20 days, the crabs will be counted, removed from the plot and their guts examined. Eelgrass and *Musculus* abundance within each plot will then be estimated.

4. Experiment 2

This experiment is designed to examine the effects of *Musculus* on eelgrass. Within the northernmost portion of the eelgrass bed at Sleepy Bay 10 1-m^2 quadrats will be set. All *Musculus* will be removed from the blades of the eelgrass within five randomly selected quadrats. The density of eelgrass, the proportion of flowering stalks, and the size of the

eelgrass turions will be measured in each quadrat after three weeks.

Alternatives

1. Do Nothing

Information compiled to date on shallow subtidal eelgrass habitats focused mainly on damage assessment, although some information on the rate and extent of natural restoration emerged. To not do further investigations into this ecologically important habitat would result in erroneous conclusions concerning natural recovery. It is essential to obtain long-term temporal data to learn the rate and extent of natural recovery to prespill conditions or to a stable community.

2. Active Restoration

Based upon the information obtained from 1990-91 damage assessment and monitoring activities it does not seem prudent at this time to move ahead with restoring specific components in the shallow subtidal eelgrass habitat. Natural recovery processes are occurring, although the rate appears to differ according to the specific components. Some restoration activity may be identified and targeted after the 1993 monitoring effort.

Location

Three oiled sites and 3 control sites have been selected from those previously studied in western Prince William Sound. In 1993, sampling will occur at the following oil/control paired sites: Bay of Isles (O)/Drier Bay (C), Herring Bay (O)/Lower Herring Bay (C), and Sleepy Bay (O)/Moose Lips Bay (C).

Benefits

No baseline information was available for the shallow subtidal eelgrass regions of PWS before the spill. It is essential then, to obtain long-term temporal data on the rate and extent of natural recovery to prespill conditions or to a stable community. Erroneous conclusions concerning the rate of recovery could occur if monitoring does not continue. Because of inherent temporal variability, most other postspill subtidal environmental studies have been three to five years in duration. To date, we have only two years of data (1990 and 1991) for the eelgrass habitat. Therefore, this subtidal monitoring project will benefit by adding a third and a fourth year.

Technical Support

Two skiffs will be needed to help in the field operations. Two inflatable boats (14 ft) with 40 hp outboards functioned best in past field efforts. These may be provided either by ADF&G or the vessel subcontractor.

Contracts

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

To date, Coastal Resources Associates (CRA) has been an integral technical component on the EVOS shallow subtidal investigations. To ensure project continuity, CRA will be contracted for field assistance. Further involvement will be required when moving into the analyses and report preparation phases of this project.

2. Support Vessel

An appropriate vessel will be subcontracted by competitive bid to carry out the field activities. The vessel must support six diving scientists for approximately two weeks during the summer of 1993.

Mitigation Measures

No mitigation action is to be taken since this project has no notable effect on the species and habitat studied.

Literature Cited

Calkins, D.G. 1978. Feeding behavior and major prey species of the sea otter, *Enhydra lutris*, in Montague Strait, Prince William Sound, Alaska. Fish. Bull. 76(1):125-131.

Faro, J.B., R.T. Bowyer, and J.W. Testa. 1993. Assessment of the effects of the EXXON VALDEZ oil spill on river otters in Prince William Sound. Final Report to the EVOS Trustee Council.

Jewett, S.C., T.A. Dean, L.J. Haldorson, D. Laur, M. Stekoll, and L. McDonald. 1993. The effects of the EXXON VALDEZ oil spill on shallow subtidal communities in Prince William Sound, Alaska. Final Report to the EVOS Trustee Council.

McConnaughey, T. 1978. Ecosystems naturally labeled with carbon-13: Applications to the study of consumer food-webs. Ph.D. dissertation, Institute of Marine Science, University of Alaska Fairbanks.127 pp.

Shaw, D.G. and M.J. Hameedi (eds.) 1988. *Environmental Studies in Port Valdez, Alaska: A Basin for Management.* Springer-Verlag, New York, 423 pp.

C. Schedules and Planning

The following activities are scheduled within this contract period:

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

July 1993: field sampling (to conform with previous sampling) and freighting sample materials to University of Alaska, Fairbanks (UAF);

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

The following activities are scheduled beyond this contract period:

Oct. - Dec. 15: laboratory analyses of the remainder of the benthic samples; analyses of sediment and hydrocarbon samples;

Dec. 15 - Jan. 15: data entry and analyses;

February 15: draft final report due to the Alaska Department of Fish and Game;

Feb. 15 - Apr. 15: Peer review of draft final report;

A final report submitted 45 days after the peer-reviewed draft report comments are received.

D. Environmental Compliance/Permit/Coordination Status

This project received a categorical exclusion under the National Environmental Policy Act (NEPA) from the National Oceanic and Atmospheric Administration (NOAA). In addition, the appropriate scientific sampling permit will be obtained from ADF&G before sampling. All operations aboard the research vessel will conform to U.S. Coast Guard safety standards. All SCUBA diving activity will conform to the UAF's scientific diving standards (UAF is a member of the American Academy of Underwater Sciences).

E. Performance Monitoring

A rigorous quality assurance/quality control (QA/QC) program will ensure the reliability and validity of field and laboratory data. A QA/QC program was initiated at the start of the project (1990) and was continued in 1991. It also will continue through the 1993 field operations, laboratory analyses, and subsequent data processing. All sample collection, labeling, preservation and storage in the field will be carried out by a team of three divers. Chain-of Custody forms with the standard signatory policy will always accompany the benthic samples and sediment hydrocarbon samples to UAF until processing has been completed. Double checking all labeling and data entry in field notebooks and on data forms will be performed by a member of the team that did not complete the original field notebook. All field and laboratory QA/QC procedures will follow those detailed in Jewett *et al* (1993).

Based on the time required to process each benthic sample (sort, identify, enumerate, and weigh) only about one-third of the samples will be completely processed by reporting time. No analyses of these data are anticipated for the progress report. The progress report will detail the field activities, e.g., quantity and quality of samples collected, and the preliminary findings of the field experiments.

F. Personnel Qualifications

Stephen C. Jewett, Principal Investigator and Research Associate at the School of Fisheries and Ocean Science (SFOS), University of Alaska Fairbanks will be responsible for the organization and the management of this project, including interpretation and synthesis of data and writing of reports. Mr. Jewett has been Research Associate at UAF since 1975. During this time he has been involved in many benthic investigations throughout Alaska, emphasizing assessment and/or monitoring. He has been the coordinator of the federal/state EVOS shallow subtidal investigations in Prince William Sound (1989-92). Mr. Jewett also serves as the Scientific Diving Officer for UAF, coordinating all scientific diving operations.

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

Thomas A. Dean, Ph.D., is President of the ecological consulting firm Coastal Resources Associates, Inc. in Vista, CA. He had major roles in both the shallow subtidal and intertidal EVOS investigations conducted through UAF since 1989. He has extensive experience in long-term monitoring studies with marine plants and invertebrates. Dr. Dean will mainly be responsible coordinating the plant investigations on this study, and assist in the carrying out of the project objectives.

David Laur, Ph.D., is Research Associate at the University of California at Santa Barbara and at UAF. He has been the coordinator of the fish component of the EVOS investigations conducted through UAF since 1989. He has extensive experience in nearshore fish population dynamics. Dr. Laur will primarily be responsible for the fish component of this study. He will also help in carrying out the other planned field components.

Kathy Omura is Laboratory Supervisor for the shallow benthic component. She has direct control of all laboratory analyses, quality control of the data, and submission of the data to Data Management at SFOS.

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

G. Budget ($k)

Personnel	$ 7.0
Travel	0.0
Contractual	230.0
Commodities	0.0
Equipment	0.0
Capital Outlay	0.0
Sub-total	237.0
General Administration	17.2
Project total	$254.2

SFOS--IMS 93-66

093453

RESEARCH PROPOSAL

TO: Alaska Dept. of Fish & Game

FROM: Institute of Marine Science
School of Fisheries & Ocean Sciences
University of Alaska Fairbanks
Fairbanks, Alaska 99775

TITLE: Subtidal Monitoring

PRINCIPAL INVESTIGATOR: Stephen C. Jewett

SS#: 004-48-2438

NEW/CONTINUING: New

PROPOSED STARTING DATE: 1 March 1993

PROPOSED DURATION: 7 mos.

AMOUNT REQUESTED: $ $230,217

Stephen C. Jewett 12/19/93
Stephen C. Jewett Date
Principal Investigator
(907) 474-7841

1 Feb 19 93
A. V. Tyler, Associate Dean Date
School of Fisheries & Ocean Sciences
(907) 474-7532

John J. Goering 12/19/93
John J. Goering, Associate Director Date
Institute of Marine Science
(907) 474-7895

12/22/93
Charles E. Graham, Director Date
Office of Sponsored Programs
(907) 474-7937

Joan Osterkamp 12-19-93
Joan Osterkamp Date
Executive Officer
School of Fisheries and Ocean Sciences
(907) 474-7824

February 1993

Project Description: Subtidal Monitoring, Part 3 - Documentation of changes in eelgrass communities in subtidal areas of Prince William Sound, Alaska.

Budget Category	Approved 1-Oct-92 28-Feb-93	Proposed* 1-Mar-93 30-Sep-93	Total FY 93	** FY 94	FY 95	FY 96	FY 97	Sum FY 98 & Beyond
Personnel	$0.0	$7.0	$7.0	$7.0	$7.0			
Travel	$0.0	$0.0	$0.0	$0.0	$0.0			
Contractual	$0.0	$230.0	$230.0	$265.0	$75.0			
Commodities	$0.0	$0.0	$0.0	$0.0	$0.0			
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0			
Capital Outlay	$0.0	$0.0	$0.0	$0.0	$0.0			
Sub-total	$0.0	$237.0	$237.0	$272.0	$82.0	$0.0	$0.0	$0.0
General Administration	$0.0	$17.2	$17.2	$19.6	$6.3	$0.0	$0.0	$0.0
Project Total	$0.0	$254.2	$254.2	$291.6	$88.3	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)	0.0	0.1	0.1					

Amounts are shown in thousands of dollars.

Budget Year Proposed Personnel:

Position	Months Budgeted	Cost	Comment
Program Manager	1.2	$7.0	

* FY 93 is a transition year from the previously used oil fiscal year to the federal fiscal year. This new project also includes proposed funding for January and February, 1993. **FY94 includes closeout funding at $70.0K.

Project Number: 93047
Project Title: Subtidal Monitoring
Sub-Project: Part 3: Eelgrass Communities
Agency: AK Dept. of Fish & Game

FORM 3A SUB-PROJECT DETAIL

		Proposed
Travel:		
Contractual:	Contract to University of Alaska, Fairbanks	$230.0
Commodities:		
Equipment:		

Project Number: 93047
Project Title: Subtidal Monitoring
Sub-Project: Part 3: Eelgrass Communities
Agency: AK Dept. of Fish & Game

FORM 3B
SUB-
PROJECT
DETAIL