1997 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997	PROPOSED FFY 1997 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
			$0.0	$358.1	$0.0	$66.2	$61.9	$98.2
Personnel	$0.0	$508.2						
Travel	$0.0	$0.0						
Contractual	$0.0	$0.0						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$508.2	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
General Administration	$0.0	$76.2						
Project Total	$0.0	$584.4						
Full-time Equivalents (FTE)	0.0	6.7						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Comments:

The funding reflected for the National Oceanic and Atmospheric Adminstration will be allocated to the Alaska Department of Fish and Game to support the Interagency Personnel Act agreement that assigns the Project Manager to NOAA.

1997

Prepared: 5/9/96

Project Number: 97250
Project Title: Project Management
Lead Agency: Various Agencies

FORM 2A
MULTI-TRUSTEE
AGENCY SUMMARY

5/9/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997
Personnel		$311.4
Travel		$0.0
Contractual		$0.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$311.4
General Administration		$46.7
Project Total	$0.0	$358.1
Full-time Equivalents (FTE)		4.1
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
$321.5	$286.8	$250.0	$214.3	$178.6	

Dollar amounts are shown in thousands of dollars.

Personnel Costs:						
Name	Position Title	GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FFY 1997
W. Hauser	FB IV	20L	12.0	7.2		86.4
D. Moore	FB III	18K	12.0	6.1		73.2
C. Rozen	Lib II	17F	12.0	5.4		64.8
Vacant	HB III	18K	6.0	6.1		36.6
Vacant	HB IV	20K	7.0	7.2		50.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		49.0	32.0	0.0	311.4

1997

Prepared: 5/9/96

Project Number: 97250
Project Title: Project Management
Agency: Alaska Department of Fish and Game

PROJECT MANAGEMENT FORM 3A

5/9/96

1997 EXXON VALDEZ TRU[illegible]E COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997
Personnel		$57.6
Travel		$0.0
Contractual		$0.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$57.6
General Administration		$8.6
Project Total	$0.0	$66.2
Full-time Equivalents (FTE)		0.8
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	

Dollar amounts are shown in thousands of dollars.

Personnel Costs: Name	Position Title	GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FFY 1997
Vacant	Program Manager	GS-13	9.0	6.4		57.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	9.0	6.4	0.0	57.6

1997

Prepared: 5/9/96

Project Number: 97250
Project Title: Project Management
Agency: Forest Service

PROJECT MANAGEMENT FORM 3A

5/9/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997
Personnel		$53.8
Travel		$0.0
Contractual		$0.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$53.8
General Administration		$8.1
Project Total	$0.0	$61.9
Full-time Equivalents (FTE)		0.8
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	

Dollar amounts are shown in thousands of dollars.

Personnel Costs:						
Name	Position Title	GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FFY 1997
D. Irons	Project Manager	GS-12	6.0	6.3		37.8
L. Thomas	Project Manager	GS-9	4.0	4.0		16.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		10.0	10.3	0.0	53.8

1997

Prepared: 5/9/96

Project Number: 97250
Project Title: Project Management
Agency: Department of the Interior

PROJECT MANAGEMENT FORM 3A

5/9/96

1997 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997
Personnel		$85.4
Travel		$0.0
Contractual		$0.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$85.4
General Administration		$12.8
Project Total	$0.0	$98.2
Full-time Equivalents (FTE)		1.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	

Dollar amounts are shown in thousands of dollars.

Personnel Costs:

Name	Position Title	GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FFY 1997
B. Wright	Project Manager	23D	12.0	7.1		85.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		12.0	7.1	0.0	85.4

1997

Prepared: 5/9/96

Project Number: 97250
Project Title: Project Management
Agency: National Oceanic and Atmospheric Administration (ADF&G)

PROJECT MANAGEMENT FORM 3A

5/9/96

corrected

Akalura Lake Sockeye Salmon Restoration

received 6/6/96

Project Number:	97251
Project Category:	Monitoring and General Restoration - restoration manipulation and enhancement
Proposer:	Alaska Department of Fish and Game
Lead Agency:	Alaska Department of Fish and Game
Cooperating Agencies:	KRAA, USFWS
Duration:	First year - FY97 (October 1- September 30); request funding from FY97 through FY04
Cost FY 97:	$388,700
Cost FY 98:	$419,000
Cost FY 99:	$369,000
Cost FY 00:	$341,000
Cost FY 01:	$240,000
Cost FY 02:	$200,000
Geographic Area:	Field work - Akalura Lake, Kodiak Island; Pillar Creek Hatchery, Kodiak Island; data analysis and report writing ADF&G, Kodiak.
Injured Resource/Service:	Biological Resource - Not Recovering - Sockeye salmon (Akalura System).

ABSTRACT

This project will restore natural production of Akalura Lake sockeye salmon (***Oncorhynchus nerka)*** through: 1) assessment of the lake rearing environment and determination of juvenile and adult life history parameters limiting sockeye salmon production; and 2) through the use of established restoration techniques to increase juvenile sockye salmon abundance, survival and adult production.

INTRODUCTION

Sockeye salmon runs to Akalura Lake have, historically, contributed significantly to the Alitak Bay District commercial, subsistence, and sport fisheries which occur on the south end of Kodiak Island. During the last 70 years, total runs (escapement plus harvest) have ranged from <3,000 (1956) to nearly 700,000 fish (1937; Edmundson et al. 1994). Recent sockeye salmon escapements (1986-1995) have averaged 37,161 fish which is similar to the historical average (45,737). In 1989, the *Exxon Valdez* oil spill (EVOS) in Prince William Sound contaminated much of the Kodiak Management Area (KMA) salmon fishing grounds (Barrett and Monkiewiez 1989) and caused closures of the commercial fishery. As a result, several sockeye salmon systems experienced escapements in excess of the escapement goals. Within the Alitak-Olga Bay District , in the absence of a fishery, the 1989 sockeye salmon escapement (116,000) into Akalura Lake was nearly twice the desired escapement level (60,000). Contemporary fisheries management programs instituted by the ADF&G provide for meeting fixed system specific biologically based escapement goals which in turn promote maximum sustained yield (MSY) for resource users. Thus, the decline of the sockeye salmon escapement into Akalura Lake to 2,010 fish in 1995 raises concern that the system may be at a production level so low that recovery to levels of MSY may not occur in the near future.

The goal of this project is to restore Akalura Lake sockeye salmon runs to levels which provide the desired escapements plus surplus fish for harvest on a sustained basis (runs of ~100,000, annually). This will be accomplished by assessment of the juvenile rearing environment and identification of juvenile and adult life history parameters that may be currently limiting production. Also, we propose to assess and institute, where feasible, the appropriate established supplemental production techniques to increase smolt survival, and the resultant adult run.

Akalura Lake is located 120 km southwest of the city of Kodiak (57°12' N 154 °12' W) on the north side of Olga Bay (Figure 1). The lake outlet drains south into Olga Bay. Akalura Lake has a surface area of 4.9 x 106 m^2, a mean depth of 9.9 m, maximum depth of 22 m, and a total volume of 48.0 x 106 m^3 (Edmundson et al., 1994).

Prior to outmigrating as smolt, juvenile sockeye salmon spend at least one year (up to 3 years) rearing in lakes. During this period of their life history, their primary forage is marcozooplankton. Excessive adult escapement into lakes results in exorbitant production of sockeye fry and taxation of the lakes zooplankton community. This in turn can lead to changes in zooplankton species composition, size and biomass, thereby lowering smolt growth, delaying outmigrations, increasing interspecific competition and lowering overwinter survival (Kyle et al. 1988; Koenings and Kyle 1991). Sockeye salmon smolt studies (EVOS F/S Study 27 - 96258) were initiated in several KMA systems including Akalura Lake in 1990 to monitor changes in smolt size, abundance and age composition in response to the overescapement event in 1989 (Barrett et al. 1993). These studies suggests that from 1990-1993 both smolt size and abundance in Akalura Lake steadily declined. Smolt outmigration estimates revealed a decline from 475,000 (1990) to 89,000 (1992) and size at age for age-1 and age-2 fish decreased by 13 and 30%, respectively, as compared to 1969-1977 (Edmundson et al. 1994). In addition, age composition shifted from predominantly age-2 smolt (>90%), to a larger proportion of age-3

smolt. Such an increase in the proportion of holdovers can indicate a less than optimum rearing environment (Koenings and Burkett 1987; Barrett et al. 1993). In 1994 and 1995 smolt production remained low (170,000 and 134,000), however, age-1 and age-2 smolt size increased to greater than the 1990-1994 average (Swanton et al. 1996). The age composition of smolts outmigrating during 1994-95 seems to have stabilized at about 45% age-1. and 53% age-2. smolts.

Limnological studies conducted in conjunction with smolt monitoring revealed little change in the amount and composition of zooplankton biomass in 1990, the year following the 1989 overescapement (Edmundson et al. 1994). In 1991 and 1992, however, the seasonal mean zooplankton biomass decreased by 70% compared to the 1990 level. Akalura Lake is relatively productive, as evidenced by concentrations of total phosphorus (mean 13 mg L^{-1}) and chlorophyll *a* (mean 4.3 mg L^{-1}). Consequently, lower escapements (~40,000) may have allowed the macrozooplankton community to largely recover under reduced grazing pressure. In 1995, the seasonal mean macrozooplankton biomass was greater (350 mg/m^2) than prior to the overescapement effect (221 mg/m^2) when over grazing was observed (1990 and 1991).

Sockeye salmon production is associated with lake fertility through food-chain linkages (Foerster 1968; LeBrasseur et al. 1978; Hyatt and Stockner 1985; Koenings and Burkett 1987; Kyle et al. 1991). In addition, many sockeye salmon nursery lakes support robust populations of stickleback within the pelagic and littoral zones. Sockeye salmon juveniles and stickleback exhibit considerable dietary overlap and competition for food is considered an important mechanism influencing sockeye salmon production (Rogers 1961; Ruggles 1965; O'Neill and Hyatt 1987). Honnold (1993) conducted hydroacoustic and townet surveys in 1990 and 1991 and found an abundant population of stickleback present in Akalura Lake. As such, juvenile sockeye-stickleback interactions and insufficient forage (zooplankton) have been suggested as factors responsible for the decline in sockeye salmon smolt production (Edmundson et al. 1994).

In 1995, sockeye salmon escapement into Akalura Lake was well below the minimum escapement goal (ADFG, unpublished data). This equates to decreased fry recruitment into the lake in 1996, and few smolts being produced from 1997-1999. In addition, the 1995 hydroacoustic estimate of fall fry abundance indicates that smolt production will be low in 1996 and 1997. As a result, the commercial and subsistence fisheries within the Alitak Bay District may be adversely affected in future years. Consequently, restoration of this system is extremely important and immediate action is necessary to enable this system to recover.

This project will be conducted cooperatively by the Alaska Department of Fish and Game (ADFG), the Kodiak Regional Aquaculture Association (KRAA) and the USFWS. We propose to assess fry recruitment and survival, smolt production, lake rearing capacity and define plans in FY97 to restore sockeye salmon fry production in Akalura Lake. These actions will facilitate restoration of Akalura Lake sockeye salmon production to historic levels.

NEED FOR THE PROJECT

A. Statement of Problem

The intent of this project is to restore Akalura Lake sockeye salmon. The EVOS Trustee Council has designated this resource injured and not recovered. EVOS Project 96258 (sockeye overescapement studies) determined that overescapement into Akalura Lake in 1989, resulted in damage to the rearing environment (Akalura Lake) due to excessive zooplankton grazing by juvenile sockeye salmon. This resulted in decreased smolt and adult production. Recent escapements into Akalura Lake have been well below minimum levels required to sustain natural production. The rearing environment (zooplankton) has recovered, however, smolt production continues to be poor with adult returns projected to remain at very low levels.

B. Rationale/Link to Restoration

This project will provide data needed to assess limits to sockeye salmon production at Akalura Lake and determine the appropriate restoration strategies. Specifically, the project is needed to determine why smolt production has declined and what level of production is needed to efficiently restore the run. The work in FY97 will provide for development of an Environmental Assessment (EA) in cooperation with the USFWS *as* required for NEPA compliance.

C. Location

The project will be undertaken at Akalura Lake, located on the southern portion of Kodiak Island. The project will benefit all communities that utilize the resource for commercial, sport, subsistence, and personal use. This includes the City of Kodiak, and villages of Ahkiok and Old Harbor.

COMMUNITY INVOLVEMENT

Local communities have been and will continue to be involved in the Akalura Restoration Project. This involvement will be facilitated through the Trustee Council, Community Involvement Project process with local facilitator from Kodiak Tribal Council (Hank Eaton), the Spill Area-wide Coordinator (Mary Vlasoff) contacted during the project implementation. The aforementioned individuals, as well as representatives from the Kodiak Area Native Association (KANA), have been informed and have provided input in project development through attendance of the Kodiak Regional Planning Team (KRPT) meeting held in March, 1996. In addition, representatives from the Subsistence Division of ADFG, attended the March KRPT meeting and will be informed on the project status. Traditional and local knowledge of commercial, sport, subsistence and personal use of Akalura Lake sockeye salmon will be incorporated into the project to assist with development of the EA. Also, ADFG and KRAA will hire locally for the project, when possible, to facilitate the use of local knowledge and expertise.

PROJECT DESIGN

A. Objectives

1. Determine the spawner location, distribution, disease incidence and fish culture parameters of Akalura Lake sockeye salmon (FY97; October - June).

2. Determine relative abundance and size of juvenile sockeye fry and stickleback populations rearing in Akalura Lake and the overwinter survival and age structure of the juvenile sockeye fry (FY97-FY02; September).

3. Develop the appropriate strategies to restore sockeye salmon production in Akalura Lake and assess NEPA compliance (FY97; November-February).

4. Prepare Pillar Creek Hatchery for the incubation and rearing necessary to support supplemental sockeye salmon production at Akalura Lake(FY97; January-March).

5. Monitor the abundance, overwinter survival, age structure and size of emigrating sockeye salmon smolt (FY97-FY02; May-June).

6. Determine the relative abundance, seasonal littoral area use, diet and growth characteristics of wild and supplemental juvenile sockeye salmon during shoal residence (FY97-FY02; June-July).

7. Determine the diet overlap (food chain linkage interaction) between sockeye salmon fry and stickleback in Akalura Lake (FY97-FY99; June-August).

8. Monitor general water chemistry parameters, nutrient levels and primary and secondary production in Akalura Lake (FY97-FY02; May-September).

9. Determine the Akalura Lake sockeye salmon run strength (escapement and harvest) and age structure (FY97-FY02; June-September).

10. Determine the supplemental production necessary, beyond natural juvenile recruitment, to increase overwinter survival and smolt production to optimum levels (equivalent to production from desired escapement of 60,000) ; collect the required number of sockeye eggs from Akalura Lake escapement and produce supplemental juveniles for subsequent release into the lake. (FY97-FY00; September).

11. Determine the effect of supplemental production on the overwinter survival, age and growth of juvenile sockeye presmolt and smolt emigrating from the lake (FY98-FY02; September-June).

12. Determine the effect of supplemental production on the smolt-adult survival and age of returns to Akalura Lake (FY01-FY06).

B. Methods

1. Determine the spawner location, distribution, disease incidence and fish culture parameters of Akalura Lake sockeye salmon (FY97; October - June).

   Akalura Lake sockeye salmon exhibit a bimodal migration, with a small early run spawning in tributaries in May and June and the more abundant, late run fish spawning primarily on lake shoals in late July and August (Edmundson et al. 1994). If escapements remain suppressed as in 1995 (2,010 fish), further information will be necessary to efficiently locate and collect brood fish in the event that supplemental production is required. Therefore, foot and boat surveys will be undertaken weekly from June through August to enumerate by sex the spawner distribution.

   State pathology guidelines require that broodstock used for rehabilitation projects be screened for disease. Akalura Lake sockeye salmon have been screened for incidence of Infectious Hemopoeitic Virus (IHNV) and Bacterial Kidney Disease (BKD) in the past (Follet, personal communication). The most recent information was collected in 1987 and indicated that this stock could be used for "self enhancement." However, more current information is needed to supplement previous results. Thus, 60 sockeye salmon will be collected and ovarian fluid and kidney tissue sampled and analyzed for IHNV and BKD incidence.

   The ADFG has ongoing sockeye salmon rehabilitation programs (funded by KRAA) at Laura and Malina Lakes on Afognak Island (Honnold and Edmundson 1993; Kyle and Honnold 1991). These programs required fish culture feasibility studies to allow supplemental production to increase to recommended levels. For example, small scale eggtakes were conducted to assess holding and ripening success, fecundity, and green egg fertilization. Also, incubation and rearing survival information was ascertained (green-to-eyed egg survival, incubation emergence timing, rearing mortality and growth, and stocking information). Similarly, for this project, in FY 97 a small number of pre-spawning adult sockeye will be captured by seining and eggs collected for incubation at Pillar Creek Hatchery (~200,000). Emergent fry will be reared at the hatchery to a size of 0.25 g and stocked into Akalura Lake in 1997. Procedures for broodstock and egg collection, incubation and rearing, and fry stocking will follow the "Sockeye Salmon Culture Policy" of the ADFG as described in the Alaska Sockeye Salmon Culture Manual (McDaniel et al, 1994).

2. Determine relative abundance and size of juvenile sockeye fry and stickleback populations rearing in Akalura Lake and the overwinter survival and age structure of the juvenile sockeye fry (FY97-FY02; September).

   A hydroacoustic survey will be conducted in October each year to estimate the number and distribution of juvenile fish. Surveys will consist of collecting (recording) data along six transects orthogonal to the longitudinal axis of Akalura Lake. The lake will be divided into three equal areas (A-C), with two transects per area selected randomly. Data will be recorded along each transect at night when juvenile sockeye salmon are more likely to be

distributed in the upper to middle part of the water column (Narver 1970; McDonald 1973; Eggers 1978; Simpson et al. 1981; Nunnallee 1983; Burczynski and Johnson 1986; Levy 1987). A BioSonics model-105 echosounder with a model-171 tape recorder interface system with 6/15° dual-beam transducer will be used for each survey. Fish signals will be recorded electronically using a Sony digital audio tape recorder (Model TCD-D10), and on chart paper using a BioSonics model-115 recorder. The specific instrumentation for data acquisition is described by Honnold (1993). Analysis of the recorded hydroacoustic tapes was conducted by BioSonics, Inc. using procedures described by Kyle (1990) and Honnold (1993).

Townetting will be conducted along the axis of the lake at depths where the highest numbers of acoustic targets are observed using a 2 x 2-m townet (Gjernes 1979). A minimum of 3 tows, ranging from 20 to 30 minutes in duration will be conducted during each survey. Fish will enumerated and weighed to the nearest 0.1 g. When greater than 200 stickleback are captured, a random sample of 100 to 150 will be counted and weighed to determine mean fish weight. The total number of stickleback will be calculated by dividing the total biomass by the average weight. Stickleback lengths will be measured from the random sample to the nearest 1.0 mm to assess length frequency. Juvenile sockeye salmon caught will be preserved in 10% buffered formalin for six weeks and then measured for fork length (to the nearest 1.0 mm), weighed to the nearest 0.1 g with the condition coefficient calculated (Bagenal 1978). Ages will be determined after Moser (1969) from scale smears mounted on glass slides using a microfiche projector. Changes in the species composition of tow-net catches will be evaluated to determine if the project is affecting the composition of the resident fish community. Analysis of variance will be used to test for pre- and post- project differences in the proportion of total catch for each species in townet samples. Analysis of variance and multiple comparison tests will be used to test for pre- and post project differences in fall fry condition factor, length, weight for each age group, respectively.

3. Develop the appropriate strategies to restore sockeye salmon production in Akalura Lake and assess NEPA compliance (FY97; November-February).

The initial year of this proposed project will focus on collecting biological data to facilitate the development of restoration strategies to elevate sockeye salmon production in Akalura Lake. We anticipate that supplemental production at some level will be required to enable the system to be self-sustaining in the future. The juvenile and adult monitoring activities, as well as the limnological assessment will be incorporated into a juvenile out stocking plan for ensuing years of the project. Specifically, estimates of zooplankton biomass and wild juvenile abundance will be the criteria used to determine the supplemental stocking level each year. The plan will also address the minimum escapements that will prompt and/or limit the use of supplemental production. Likewise, these criteria will be used to determine when supplemental production is no longer necessary.

The results from EVOS study 96258 and adult monitoring data collected as part of normal agency management (ADFG) will assist with achieving this objective.

An EA will evaluate the various restoration alternatives and specific strategies for rehabilitating Akalura Lake sockeye salmon to assure NEPA compliance.

4. Prepare Pillar Creek Hatchery for the incubation and rearing necessary to support supplemental sockeye salmon production at Akalura Lake(FY97; January-March).

Pillar Creek Hatchery (PCH) was constructed in 1990 near the City of Kodiak, as a State of Alaska incubation and short-term rearing facility (Honnold and Clevenger 1995). The facility was operated by ADFG until 1993, when KRAA began funding portions of it's operation. By 1995, the hatchery was fully funded by KRAA. Several sockeye salmon rehabilitation projects on Kodiak Island (Afognak, Malina, and Laura Lakes) are facilitated by the incubation, rearing, and supplemental stocking of juvenile fry and pre-smolt from PCH. Since PCH has an ongoing sockeye salmon rehabilitation program, the facility will be used for incubation, marking, and rearing for this project. Therefore, in preparation for Akalura Lake supplemental production, PCH will be modified, where required (determined by objective 3). Presently, little space is available at PCH for new projects; therefore, these modifications will be required prior to use of the facility for Akalura Lake restoration. The funding request will provide for initial modifications in FY 97 to allow for proceeding with the project in a timely manner in FY 98. If it is determined, however, during the peer review and NEPA process, that PCH is not required for restoration, spending for modifications will be curtailed. For planning purposes in FY97, the maximum supplemental stocking level is assumed to be 5 million juveniles. The following modifications will be undertaken: 1) incubation module separation to assure isolation of Akalura Lake sockeye eggs from other stocks present in the facility; 2) rearing space expanded to provide for juvenile emergence and short-term and extended rearing; 3) increase hatchery water flow regime to provide for the additional incubation and rearing; 4) upgrade equipment necessary for expanded hatchery maintenance and monitoring (plumbing, oxygen system, electrical, alarm system, transport, and repairs).

Also, net pens, net pen frames, beach seines, weatherports, safety gear and supplies for a remote egg take at Akalura Lake will prepared and staged at PCH.

5. Monitor the abundance, overwinter survival, age structure and size of emigrating sockeye salmon smolt (FY97-FY02; May-June).

A Canadian fan trap (Ginetz 1977) equipped with a live box and perforated plated leads will be operated in the outlet creek to estimate the number of migrating smolt and to sample for AWL information (Swanton et al, 1996). The trap will be operated continuously from early May to mid-June. The trap catch efficiencies will be determined by mark-recapture methods with a minimum of 500 smolt marked and released (Rawson 1984; Swanton et al. 1996). Overwinter survival will be estimated by comparing the number of emigrating smolt to the fall fry estimates from the previous October. Smolts will be anesthetized in a tricaine methanesulfonate (MS-222) solution, measured for length (FL) to the nearest 1.0 mm, and weighed to the nearest 0.1 g. A scale smear will

be taken from each measured fish, placed on a glass slide, and aged using a microfiche projector. Analysis of variance will be used to test for pre- and post-project (supplementation) differences in the proportion of total smolt abundance by age class and also for differences in smolt condition (length and weight). Finally, overwinter survival variance will be estimated as described by Seber (1982).

6. Determine the relative abundance, seasonal use, diet and growth characteristics of wild and supplemental juvenile sockeye salmon during shoal residence (FY97-FY02; June-July).

   Shoal sampling sites will be developed at four locations at Akalura Lake similar to those used previously (ADFG unpublished data). These sites will be sampled weekly from May through early July using a 15 m x 2 m beach seine with 6 mm stretch mesh. Two sets will be made on opposite sides of a demarcating fence post. The catches from each set will be enumerated by species with TL and weight recorded for sockeye juveniles to the nearest 1.0 mm and 0.1 g, respectively. Analysis of variance will be used to test for pre- and post-project (supplementation) differences in mean CPUE (or other relative abundance indices), and size (length and weight). Additionally, 25 sockeye and stickleback each will be collected for diet analysis (Koenings et al. 1987). Individual fish will be preserved in 10% buffered formalin and AWL data collected. Gut content analysis will be conducted to identify prey abundance by species.

7. Determine the diet overlap (competition) of sockeye salmon fry and stickleback in Akalura Lake (FY97-FY99; June-August).

   The relative abundance of juvenile sockeye and stickleback will be estimated by monthly townet surveys at Akalura Lake from June through August. Townetting, fish enumeration, sizing and other methodology will be conducted as described for objective 2. Additionally, 25 sockeye and stickleback each will be collected for diet analysis in August (Koenings et al. 1987). Individual fish will be preserved in 10% buffered formalin and AWL data collected. Gut content analysis will be conducted to identify prey abundance by species.

8. Monitor general water chemistry parameters, nutrient concentrations and primary and secondary production in Akalura Lake (FY97-FY02; May-September).

   Lake water samples will be collected at two locations (stations) from both the 1 m (epilimnion) and the 10-20 m (hypolimnion) strata using a non-metallic Van Dorn sampler. Approximately eight liters of water will be collected from each depth and filtered and/or preserved at the ADFG office for later laboratory analysis. A portion of the water samples will be refrigerated for general tests and metals, another portion frozen for Kjeldahl nitrogen and total phosphorus testing, and a final portion filtered through a Whatman GFF glass-fiber filter and frozen for analysis of dissolved nutrients. All samples will be sent to the ADFG Limnology Laboratory in Soldotna for analysis as described by Koenings et al. (1987).

Conductivity (temperature compensated to 25° C) will be measured with a YSI model-32 conductance meter, and pH measured with a Corning model-A specific ion meter. Alkalinity levels will be determined by acid titration (0.02 N H_2SO_4) to pH 4.5 (AHAP 1985). Turbidity, expressed as nephelometric turbidity units (NTU), will be measured using a HF model-DRT100 turbidimeter, and color determined on filtered samples by measuring the spectrophotometric absorbance at 400 nm and converting to equivalent platinum cobalt (Pt) units. Calcium and magnesium will be determined from separate EDTA (0.01 N) titration's after Golterman (1969), and total iron analyzed by reduction of ferric iron with hydroxylamine during hydrochloric acid digestion after Strickland and Parsons (1972). Filterable reactive phosphorus (FRP) will be analyzed by the molybdate-blue/ascorbic-acid method of Murphy and Riley (1962), as modified by Eisenreich et al. (1975). Total phosphorus will be determined using the FRP procedure, after persulfate digestion. Nitrate and nitrite ($NO_3 + NO_2$) will be assessed as nitrite after cadmium reduction and diazotization with sulfanilamide, and total ammonia determined using phenylhypolchlorite methodology (Stainton et al. 1977). Total Kjeldahl nitrogen (TKN) will be determined as total ammonia following sulfuric acid block digestion (Crowther et al. 1980). Total nitrogen will be calculated as the sum of TKN and $NO_3 + NO_2$. Finally, reactive silicon will be estimated ascorbic acid reduction to molybdenum blue (Stainton et al. 1977).

Samples for phytoplankton analysis will be preserved in Lugol's acetate solution (Koenings et al. 1987) and analyzed by Eco-Logic Ltd., Vancouver, British Columbia. Algal standing crop will be estimated by the algal pigment chlorophyll *a* (chl *a*) with samples prepared by filtering 1 to 2 L of lake water through a Whatman 4.25-cm GFF glass-fiber filter, and 1-2 ml of saturated $MgCO_3$ solution added prior to completion of filtration. The filters will be stored frozen in individual plexislides for future analysis. Pigment will be extracted after homogenizing glass-fiber filters in 90% acetone using a tissue grinder and pestle. Concentrations of Chl *a* (corrected for inactive phaeophytin) will be determined using the fluorometric procedure of Strickland and Parsons (1972) with low-strength acid will be used to estimate phaeophytin (Riemann 1978).

Bottom-to-surface zooplankton hauls will be taken using a 0.2-m diameter, 153-m mesh, conical net. The net will be pulled manually at a constant ~0.5 m sec^{-1}, and rinsed prior to removing and preserving all specimens in neutralized 10% formalin (Koenings et al. 1987). Identification of *Daphnia* will follow Brooks (1957), *Bosmina* after Pennak (1978); and the copepods after Wilson (1959) and Yeatman (1959). Enumeration will consist of counting triplicate 1-ml subsamples taken with a Hansen-Stempel pipette in a 1-ml Sedgewick-Rafter cell. Zooplankton body sizes will be obtained by measuring the length to the nearest 0.01 mm of at least 10 individuals along a transect in each 1-ml subsample (Koenings et al. 1987) and, zooplankton biomass, weighted by organism density, will be estimated from specie-specific regressions of zooplankter body length and weight after Koenings et al. (1987).

9. Determine the Akalura Lake sockeye salmon run strength (escapement and harvest) and age structure (FY97-FY02; June-September).

An adult enumeration weir has been operated historically to determine escapement into Akalura Lake (Edmundson et al 1994). The annual operation of this weir will support this project. Inclusive of the weir operation is the objective of sampling the adult sockeye escarpment for age, whereby approximately 500-1000 scales will be collected annually. A scale will be taken from each fish, and ages determined from acetate impressions using a microfiche projector.

The historical annual harvest of Akalura Lake sockeye salmon is largely unavailable because this stock was a harvested in a mixed-stock fishery with no means to separate Upper Station late run fish from Akalura fish (Edmundson et al, 1994). Previous estimates of Akalura Lake late run sockeye salmon contribution to the commercial catch employed an Upper Station to Akalura late run escapement ratio estimator (Edmundson et al. 1994). This approach will be refined for this proposed project. Commercial catch data will be collected from both Cape Alitak and Moser-Olga Bay sections similar to what has been undertaken since 1985, at a rate of 600 scales by section.

10. Determine the supplemental production necessary, beyond natural juvenile recruitment, to increase overwinter survival and smolt production to optimum levels (equivalent to production from desired escapement of 60,000) ; collect the required number of sockeye eggs from Akalura Lake escapement and produce supplemental juveniles for subsequent release into the lake. (FY97-FY00; September).

Each year, based on the limnological data and escapement levels, recommendations for supplemental production will be delineated. These recommendations will occur by August 1 and will determine the number of sockeye salmon eggs required by PCH for incubation and supplemental production of juvenile sockeye salmon. Aerial and foot surveys will be conducted to determine when sufficient sockeye are holding near the mouth of major spawning tributaries. Brood source fish will be seined and sorted by sex and held in net pens in Akalura Lake until females have ripened. Remote egg collection will follow procedures outlined by McDaniel et al (1994). After fertilization, disinfection and water hardening, eggs will be chilled in ice filled coolers to delay development in preparation for transport to the city of Kodiak. Disease screening will be conducted to determine titer levels of IHN virus in ovarian fluid. Eggs will be transported by float plane to the city of Kodiak and then transported to Pillar Creek Hatchery. Eggs will be acclimated to water temperature prior to seeding into Kitoi box incubators and fertility will be checked as a quality control measure to assure high green to eyed egg survival.. Egg density in each incubator will be 250,000 with flows set at 10 gpm.

During the incubation period, temperature units (TU) will be monitored daily to track egg development. Eggs will be treated with formalin as required to control fungus. Other general maintenance will be conducted according to ADFG and KRAA fish culture operational standards. After reaching the eyed egg staget, eggs will be shocked

and dead and live eggs will be enumerated to calculate green to eyed egg survival. Incubators will be maintained throughout the rest of the incubation period following operational standards as previously mentioned.

Sockeye fry will volitionally migrate from incubators to raceways. Akalura Lake fry will be segregated from other hatchery stocks in raceways according to ADFG compartmentalization policy (McDaniel et al 1994). Fry will be enumerated as they enter the raceways using an electronic counter. Fry will be fed, beginning with omp semi moist starter mash. After reaching 0.3 g in size, fry will be fed omp semi moist pelletized feed. Rearing fry will be sampled weekly to estimate feed conversion and growth.

After fry reach 0.25 g and/or when Akalura Lake surface water temperatures reach 6°C, (period of wild stock migration from shoal rearing area), a portion of the juveniles will be stocked into Akalura Lake. In mid summer when the zooplankton community is at peak production (monitored by limnological sampling), another portion of the juveniles (~1.5-2.0 g) will be stocked. The remainder of the juvenile sockeye salmon will be reared until late October (~8-10 g) and stocked into the lake just prior to freeze up.

Juveniles will be removed from raceways and transported in an oxygenated tank from PCH to a float plane staging area. There they will be transferred to a transport tank in a float plane where they will be monitored by a fish culturist while in transit to Akalura Lake. Fry will be released into Akalura Lake after being acclimated to the lake water temperature.

11. Determine the effect of supplemental production on the overwinter survival, age, and growth of juvenile sockeye presmolt and smolt emigrating from the lake (FY98-FY02; September-June).

Marking will be conducted at PCH prior to supplemental lake stocking (potentially) using ventral and adipose fin clips for differentiation of stocking lots in addition to identifying wild from supplemental smolt production. The number of marks will be determined by the ADFG biometric staff once stocking numbers, desired accuracy level, and available funds are defined. A fairly large number of fry will be necessary due to the estimated low survival rate of released fry, which violates the closed population assumption of most mark- recapture designs (Thompson 1992 and Cormack 1981).

Hydroacoustic/townet surveys and smolt mark recapture techniques will be employed to determine overwinter survival, age, and size characteristics of supplemental and wild juveniles. The methodology will be the same as described previously. Surveys will occur in September or October. In addition, all sockeye salmon juveniles captured by townet will be examined for marks. Smolt sampling will occur from early May to the end of June. Potentially, a random sample of each nights smolt catch will also be examined for marks to apportion survival of the stocking lots. Ratio estimators developed for dealing with coded wire tag data will likely be employed to determine the

overall overwinter survival by lot and size. ADFG biometric staff will assist with determining sample sizes and the analysis of data.

12. Determine the effect of supplemental production on the smolt-adult survival and age of returns to Akalura Lake (FY01-FY06).

Samples of adult sockeye salmon will be collected and examined for marks during weir operation and from the harvest. This information will analyzed to determine smolt to adult survival of supplemental production. The number of adults necessary to examine for marks will be determined by ADFG biometrics staff.

The Trustee Council, in 1995, developed criteria and guidelines to assess supplementation projects. The emphasis of these criteria and guidelines is to assure that benefits outweigh risks for proposed supplementation projects.

The benefits of rehabilitating Akalura Lake sockeye salmon include the rebuilding of the population to levels which would provide for commercial, sport, subsistence harvest. The 1995 run (~9,000) was extremely depressed, and could decline even further without supplementation. Thus, restoring this system may prevent the potential for extinction of sub populations of Akalura Lake sockeye salmon.

Genetic risks are of concern for supplementation projects. This restoration project is not expected to result in any risk to natural stocks being targeted (Akalura Lake sockeye salmon) nor any non-targeted stocks. Supplemental production will utilize only native Akalura fish for hatchery culture to increase juvenile survival. Also, criteria will be developed to determine minimum escapement levels which will trigger supplemental production. This will assure that target stock brood fish will not be collected at escapement levels, which in the event of a hatchery failure, could result in risk to the native gene pool. Also, when escapement levels trigger supplemental production brood fish will be selected randomly from all sub populations of the native stock, to minimize the risk of extinction.

This project will not create mixed stock fishery concerns as the management plan for both the Cape Alitak and Moser-Olga Bay sections is clearly defined with regard to which species will be managed for during specific time periods. This management plan has been in effect since 1988 during which period the minimum sockeye salmon escapement goal (40,000 fish) for Akalura has been achieved in all years except those where decreased production could be attributed to the 1989 escapement of 116,000 fish.

If successful, this project will result in restoring natural production levels of the Akalura Lake system. Edmundson et al (1994) reported that at full production, the system is capable of producing 100,000 sockeye salmon, annually. This would provide a 40 - 60,000 fish harvestable surplus, worth approximately $200,000-$300,000 to resource users each year. Other unquantifiable values, such as preventing extinction of subpopulations of the resource, and restoring historical use will occur as result of this project.

In March, 1995 the KRPT expressed support for the restoration of Akalura sockeye salmon. In addition a Fish Transport Permit (FTP) is in preparation to provide thorough review of this project by the ADFG. The PCH management plan will also be amended and reviewed by ADFG and KRAA upon approval of this proposal. The appropriate federal permits will be obtained from the US Fish and Wildlife Service prior to conducting any work on Kodiak National Wildlife Refuge lands of which the Akalura Lake system is included. Lastly, the evaluation of environmental effects according to standards of the NEPA will be completed in FY97 as result of this project.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

ADFG, KRAA, and USFWS will cooperate on this project. In FY 97, ADFG will be responsible for determining juvenile and adult sockeye life history and rearing environment status, and the appropriate strategies to increase natural productivity of Akalura Lake. This will include defining the level of supplemental production required to increase overwinter survival and smolt production. ADFG will be responsible for permitting (FTP, amend PCHMP, special use permits) and NEPA reporting (EA). In FY 97, KRAA will be responsible for evaluating spawner location, distribution and disease incidence and assessment of fish culture parameters. In addition, KRAA will be responsible for determining the incubation and rearing capacity of PCH necessary to support supplemental production. This will include hatchery modifications, and all preparations for future supplemental production efforts. The USFWS will cooperate by assisting with historical data compilation and review to supplement development of the EA.

SCHEDULE

A. Measurable Project Tasks for FY 97

Oct 1-15:	Spawner surveys, disease screening, egg collection
Oct 1-10:	Abundance, survival and growth estimates -Hydroacoustic/townet surveys
Nov 1-Dec 31:	Production evaluation, prepare NEPA compliance documents, permitting
Jan 1-Mar 30:	Modify PCH -order materials, equipment, etc. Recruit for personnel
Apr 1-30:	Finish PCH modifications; order smolt, fry sampling, and hydro/tow supplies and complete personnel recruitment
April 1-15:	Prepare and submit DPD
May 1-Sept 30:	Smolt, fry, stickleback, limnology, escapement data collection
Sept 1-30:	Determine supplemental production level; prepare for remote eggtake and collect required eggs

B. Project Milestones and Endpoints

The project's milestones and endpoints are described in the Project Design, Objectives section. The Objectives for FY 97 focus on development of specific restoration strategies, which will provide guidance for further detailing of project milestones. Presently, data indicates that supplemental production may be an appropriate restoration technique for Akalura Lake sockeye salmon. If further data collection, as proposed for FY 97, supports current information, supplemental production will begin in FY 98. The evaluation of supplemental production will continue through the adult sockeye salmon return cycle which would be 5-6 years after the final year of stocking(~FY 06).

C. Completion Date

The majority of the restoration objectives are expected to be complete by FY 04, with evaluation of adult returns continuing until FY 06. Again, this schedule is dependent upon restoration development proposed for FY 97.

PUBLICATIONS AND REPORTS

A document will be written in FY 97 assessing the environmental effects of the project as required by the NEPA. The EA will be submitted to the appropriate federal agency by 01 February, 1997.

PROFESSIONAL CONFERENCES

Principle Investigators (PI) will attend the annual 1997 Restoration Workshop sponsored by the Trustee Council. The PI's will also attend a statewide Fisheries Acoustic workshop that is being proposed for 1997. Lastly, PIs will attend a Sockeye Workshop sponsored by Private Non-profit aquaculture associations and ADFG. The dates and locations of these workshops are pending at this time. The attendance of these workshops is intended to provide PIs with current information on sockeye salmon restoration and evaluation techniques that will aid in the implementation of this project.

NORMAL AGENCY MANAGEMENT

Previous studies of Akalura Lake sockeye salmon (F/S 27; 96258) have provided evidence of damage to the resource as result of the 1989 EVOS. If the EVOS had not occurred, the resultant damage to Akalura Lake sockeye salmon productivity, presumably, would not have occurred. Thus, ADFG, KRAA, and the USFWS would not have been involved in damage assessment or restoration activities at Akalura Lake. Currently, the ADFG in cooperation with KRAA is conducting restoration projects at four Afognak Island sockeye salmon systems (Afognak, Malina, Laura, and Portage Lakes). These entities have also worked on

rehabilitation projects at Karluk and Frazer Lakes located on the southern portion of Kodiak Island.

This project is necessary to prevent further decline of Akalura Lake sockeye salmon production and to assure the sustainability of these runs in the future. In addition, this project will provide continued evaluation of resource damage that has been documented by (F/S 27; 96258). This project will also improve management of the resource by providing limnological and fishery data that will aid pre-season forecasting. The likelihood for alternative funding sources for collection of this data is remote, since the ADFG is expected to absorb further budget reductions in the near future. Also, KRAA is projecting near- term revenue declines as result of poor salmon prices and will be cutting operational costs.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will be integrated and coordinated with existing ADFG and KRAA projects. Personnel, equipment and expertise in rehabilitation procedures that are currently, or have been used will supplement this project. For example, in FY 97, personnel that routinely manage and conduct hydroacoustic surveys, smolt mark-recapture studies, limnology sampling, hatchery eggtakes, incubation and rearing will assist with this project. Hydroacoustic gear, rafts and outboard engines, smolt and limnology sampling equipment and hatchery gear will supplement the required equipment for this project. Logistics required will also be coordinated with other projects located in the vicinity of Akalura Lake (air and vessel charters, etc.). The ADFG weir operation at Akalura will assist with data collection for this project. It is anticipated that other "in kind" costs will be provided to this project including biologist 's salaries for preparing and reviewing reports, fish culturist's salaries for operation and maintenance of PCH, and other costs associated with PCH (utilities).

PROPOSED PRINCIPAL INVESTIGATOR(S)

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PERSONNEL QUALIFICATIONS

Principal Investigators

Steven G. Honnold
Alaska Department of Fish and Game, CFMD Division
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July, 1995 to present. Area Resource Development Biologist. Responsibilities include development and management of salmon rehabilitation and enhancement programs on Kodiak Island and the Alaska Peninsula. This includes ongoing sockeye salmon enhancement projects at Spiridon, Hidden, Crescent, Waterfall, and Jennifer Lakes, rehabilitation projects at Afognak, Malina, Laura, and Portage Lakes, monitoring of post-project productivity status at Karluk, and Frazer Lakes and feasibility work on 23 lakes on the Alaska Peninsula. Responsible for evaluation of pink, coho, chum and sockeye salmon production at Kitoi Bay Hatchery, and sockeye salmon production from Pillar Creek Hatchery. Also, responsible for EVOS habitat restoration project at Little Waterfall Creek and lake assessment at Red and Akalura Lakes (F/S 27; 96258). Supervise limnology sampling on all Kodiak Island and Alaska Peninsula lakes, fishpass projects on Afognak Island, hydroacoustic sampling and various sockeye salmon smolt sampling projects on Kodiak Island and the Alaska Peninsula.

March 1989 to July 1994. Assistant Area Biologist, ADFG, FRED Division . Responsible for oversight of lake limnology sampling, fishpass projects, EVOS damage monitoring and restoration projects, and hydroacoustic sampling at up to 20 salmon systems. Assisted with the development of enhancement and rehabilitation projects throughout the Westward Region. Also assisted with development of Pillar Creek Hatchery and evaluation work at Kitoi Bay Hatchery.

May 1986-February 1989. Fish Culturist, ADFG, FRED Division. Worked at Big Lake, Kitoi Bay, Fort Richardson and Elmendorf Hatcheries culturing all species of pacific salmon. Also assisted with hatchery evaluation work at Big Lake, including weir and smolt projects.

Charles O. Swanton
Alaska Department of Fish and Game, CFMD Division
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Regional Salmon Research Biologist

1995-Present. Regional Salmon Research Biologist. Responsible for supervision of all salmon research activities within the Westward Region. The projects include: sockeye salmon smolt outmigration studies (Kodiak and Chignik), run reconstruction and brood

table development for eight sockeye stocks, and escapement goal evaluation and preseason run forecasting.

1991-1994. Kodiak Area Salmon Research Biologist. Supervised salmon research activities conducted on Kodiak salmon stocks. Projects include: salmon catch and escapement age, length, and sex data collection; inseason sockeye salmon test fishery and stock separation; population assessment of sockeye smolts and rearing fry; and Frazer Lake fry, smolt, and adult population assessment. Inseason, evaluate sockeye salmon run strength and postseason conduct run reconstruction and escapement goal formulation. Perform data analysis and provide technical support for all Westward region stock separation projects.

1989-1991. Principal Investigator EVOS F/S study 7b&8b. Responsible for all scientific and administrative facets of Exxon Valdez oil spill damage assessment studies conducted on Kodiak and Chignik pink salmon populations. Assessment included collection and analysis of stream residence time, fecundity, egg retention, available spawning habitat, preemergent fry, escapement and commercial catch data.

Assisting Personnel

Ivan Vining
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July, 1995 to present. Biometrician II (this position requires a minimum of a Masters Degree in either statistics or biostatistics, my Masters degree is in biostatistics). My responsibilities center around developing, analyzing, and reporting fisheries studies associated with stock population parameters including population abundance, multi-stock and age separation, growth rates, survival rates, and maturity models. The species which these types of work were done are: king crab (blue and red), Tanner crab (opilio, bairdi and tanneri), Korean hair crab, spot shrimp, salmon (sockeye, coho, chinook, chum and pink), herring and several species of groundfish (specifically pollock, black rockfish, sablefish and Pacific cod). The data collected for these studies has been from weir samples, dip-net samples (both within a river system and hatchery), trawl surveys, pot surveys, and catch samples. The job also requires assisting biologists on simple and complicated presentations and reports which must be submitted to such agencies as the Alaska Board of Fisheries and the North Pacific Fisheries Management Council and reviewing written material for publication. The job has recently required setting up and using GIS packages. Lastly, this job requires supervising two other biometricians (Biometrician Is).

October, 1991-June, 1995. Biometrician I (same requirements as Biometrician I). The responsibilities for this position are the same as for the Biometrician I, except it did not require supervising anyone.

Dana Charles Schmidt
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Commercial Fisheries Management and Development Division
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October, 1991 to present. Limnologist III, Principal Limnologist, FRED Division, Alaska Department of Fish and Game, Soldotna, AK. Responsibilities include establishing research objectives for the Statewide limnological investigations of the Commercial Fisheries Management and Development Division. This section provides direction for other components of the Division for determination of stocking rates for sockeye salmon in lakes and in the application of fertilization. This section also provides input to the commercial fisheries division for determination of the escapement goals for sockeye salmon. Supervise the limnology laboratory which completes water quality and plankton analysis for water samples taken from several hundred lakes statewide.

April, 1985 to October, 1991. Fishery Biologist IV, Regional Research Biologist, Westward Region, Alaska Department of Fish and Game. Responsible for establishing research objectives and priorities for the Westward Region Commercial Fisheries Division. This Division has management authority over extensive salmon and herring stocks on the Alaska Peninsula and Kodiak Island, in addition to management of the major shellfish stocks in the Gulf of Alaska and the Bering Sea. Annual ex-vessel value of these fisheries is several hundred million dollars, Research highlights included studies of crab larvae settling rates in the Gulf of Alaska and investigations on the effects of oil spill overescapement on the sockeye salmon production of major lakes on Kodiak Island.

May, 1982 to September, 1985. Acting F.B. IV, Susitna River Aquatic Studies Coordinator, Alaska Department of Fish and Game. The entire program under supervision included approximately 25 permanent and 50 seasonal employees. During this interim period, responsible for reorganizing the studies into a more efficient structure to meet the long term monitoring needs for determination of the effects of the Susitna project on the aquatic resources of the Susitna River. Supervised development of operational plans for 18 technical study programs on the Susitna River, assignment of priorities of tasks, and review of the technical merit of the programs proposed. Prior to January 1985. F.B. III, Resident and Juvenile Anadromous Project Leader, Su-Hydro Aquatic Studies Program, Alaska Department of Fish and Game. Supervised research programs on resident and juvenile anadromous fish in the Susitna River that may be impacted by development of the Su-Hydro Project. Technical studies included development of models of sport fishery exploitation on arctic grayling populations, modeling instream flow responses of juvenile salmon habitat, development of baseline population parameters of resident fish and juvenile salmon and development of projections of supersaturated gas dissipation below the proposed dam sites.

January, 1981 to May, 1982: Fishery Biologist, Terrestrial Environmental Services, Anchorage, Alaska. Responsible for field and office review of the aquatic studies programs of the Alaska Power Authority for the Susitna Hydro-Electric Program. This responsibility included assisting the Alaska Department of Fish and Game in study plan development, providing preliminary assessment of impacts of the project on aquatic resources and presenting to the public progress of the aquatic studies programs.

May, 1980 to October, 1980: Fishery Biologist, U.S. Fish and Wildlife Service, Soldotna, Alaska. Assisted on a radio-telemetry project and juvenile salmon habitat survey on the Kenai River, 6-mile Creek and the Deshka River in the Cook Inlet area. Activities included tagging and radio tagging chinook and coho salmon, collection of juvenile salmon and measurements of associated habitat, and assisting in the analysis of scale patterns from Kenai River chinook salmon. Other activities included statistical analysis of data, report review and preparation of a publication on the Kenai River chinook for Alaska magazine.

Education:
Ph.D. in Fisheries 1973
Major Field - Fisheries- Minor Field Pharmacology,
Oregon State University, Corvallis, Oregon
M.S. in Biology, 1970 Major Field - Aquatic Biology Minor Field - Sanitary Biology,
University of Utah, Salt Lake City, Utah
B.S. in Wildlife Biology, 1968, University of Montana, Missoula, Montana

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April, 1977 to April, 1988: Project Biologist and later Area Biologist for the Division of Fisheries Rehabilitation, Enhancement, and Development of the ADF&G in Soldotna Alaska. Conducted and evaluated various fisheries enhancement and evaluation projects in the Cook Inlet watershed including limnological investigations of sockeye salmon producing lakes, and evaluation of hatchery stocking programs. Also, during the period I served as a project limnologist for the Limnology Section which involved the collection, analysis, and interpretation of limnological data from sockeye nursery lakes for assessment of rearing capacity and for modeling purposes.

April, 1988 to present. Regional Limnologist for the Limnology Section for ADF&G in Soldotna, Alaska. Supervised by Dr. Dana Schmidt. As the Regional Limnologist for the Southcentral Region comprising of the Interior, PWS, Cook Inlet, and Alaska Peninsula; the primary purpose of this position is the supervision of staff in the coordination, assignment, prioritization, analysis, and review of subordinates work and

interagency contract work related to lake fertilization and stocking projects, water quality monitoring projects, and fisheries and limnological research. In addition, the position is responsible for training subordinates, reporting and review of project results for publications and meetings, and administrating state and non-state (contract) budgets.

Education: 1975 Bachelor of Science, Life Science/Natural Resources, University of Wisconsin.

Publications: A total of 34 technical reports, 8 journal manuscripts, 24 formal presentations, and 6 magazine articles dealing with adult sockeye production, lake fertilization, lake stocking, and in-lake assessments of juvenile sockeye production.

Chris Clevenger
Alaska Department of Fish and Game, CFMD Division
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July, 1994 to present. Hatchery Manager. Responsible for development and operation of KRAA Pillar Creek Hatchery. Duties include remote sockeye salmon eggtakes, incubation, rearing and stocking of juveniles, and scientific/education projects.

July, 1990 to July, 1994. Hatchery Manager, ADFG, FRED Division. Responsible for development and operation of Pillar Creek Hatchery. Duties include remote sockeye salmon eggtakes, incubation, rearing and stocking of juveniles, and scientific/education projects.

October, 1985 to July, 1990. Assistant Hatchery Manager, ADFG, FRED Division. Assisted with oversight of all sockeye and coho salmon fish culture duties at Big Lake Hatchery.

Steven T. Schrof
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April, 1994 to present. Fishery Biologist. Responsible for field projects associated with enhancement and development programs on Kodiak Island. This includes hydroacoustic surveys, sockeye smolt condition sampling, lake limnology sampling, and fishery monitoring.

July, 1993 to April, 1994. Fishery Technician III. Responsible for limnology sampling, stream surveys, disease screening, and juvenile sockeye and coho sampling at 23 Alaska Peninsula Lakes.

May, 1988 to July, 1993. Fish Culturist. Assisted with fish culture duties for all species of pacific salmon at Pillar Creek, Snettisham, and Deer Mountain fish hatcheries.

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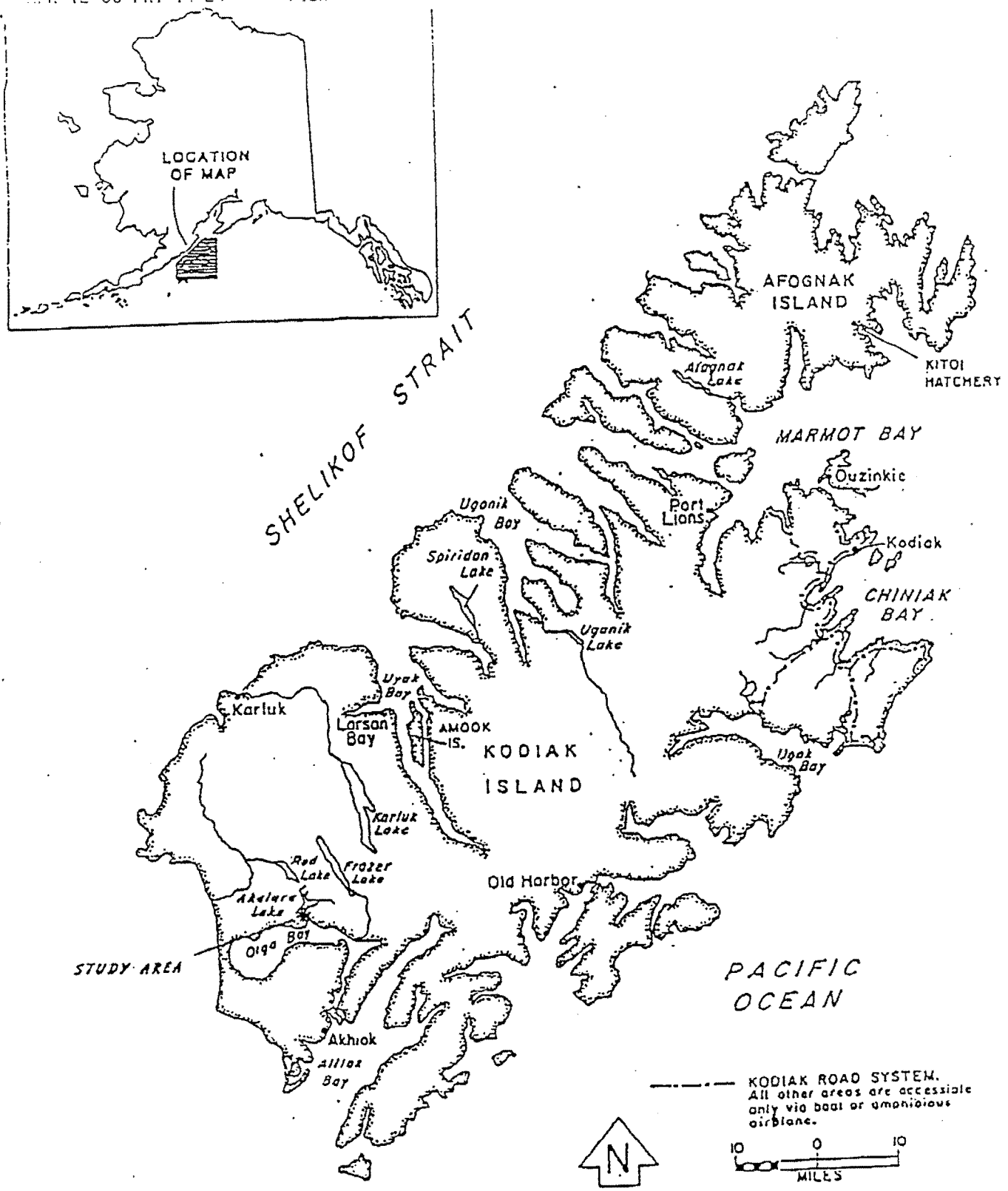

Figure 1. Location of Akalura Lake on Kodiak Island.
(Project No. 97251) ■ 27

Investigations of Genetically Important Conservation Units of Species Inhabiting the EVOS Area

Project Number:	97252
Restoration Category:	Research
Proposer:	ADF&G
Lead Trustee Agency:	ADF&G
Cooperating Agency:	None
Alaska SeaLife Center:	Yes
Duration:	7 years
Cost FY 97:	$ 49,800
Cost FY 98:	$ 152,000
Cost FY 99	$ 446,000
Cost FY 00	$ 446,000
Cost FY 01	$ 446,000
Cost FY 02	$ 446,000
Cost FY 03	$ 446,000
Geographic Area:	Prince William Sound, Kodiak Island, Kenai Peninsula
Injured Resource/Service:	Vertebrate and invertebrate species in EVOS area

ABSTRACT

The purpose of this project is to plan the consolidation of all of the Trustee Council-funded projects of the Alaska Department of Fish and Game (ADF&G) Genetics Laboratory into the facilities at the Alaska SeaLife Center in Seward. This project will eventually become the principal project into which all other oil-spill related studies conducted by the ADF&G Genetics Laboratory will be integrated. The genetics laboratory developed in the Alaska Sealife Center through this project will also provide core facilities for the genetic analysis of populations of marine fish and non-fish vertebrates and invertebrates for principal investigators conducting research at the Seward facility.

INTRODUCTION

The first year of this project will be spent planning and preparing for the eventual relocation of projects to the Alaska SeaLife Center (ASLC) upon completion in the summer of 1998. It is our intent to relocate the Trustee-Council funded projects that are currently conducted through the Alaska Department of Fish and Game (ADF&G) Genetics Laboratory in Anchorage to the ASLC. These projects include *Genetic Structure of Prince William Sound Pink Salmon* (Project 96196) and *Genetic Discrimination of Prince William Sound Herring Populations* (Project 96165); the scope of investigations will expand to include other species in future studies. Additionally, studies such as *Construction of a linkage map for the pink salmon genome* (Project 97190) will be supported through the development of experimental runs of Pacific salmon that will be maintained at the ASLC by this project, and other studies such as *Cutthroat and Dolly Varden in Prince William Sound* (Project 97145), could greatly benefit from the presence of a core genetics laboratory in the spill area.

Finally, time will be spent during this period to identify species and populations within the spill area whose conservation and management would benefit from delineation of their genetic structure. The legacy of the *Exxon Valdez* oil spill (EVOS) studies will largely entail a better understanding of the species that inhabit the spill-affected area, to which genetic studies of population structure contribute greatly. Such baseline knowledge is important not only in case of another catastrophe along the northwest coast of the Gulf of Alaska, but also nationwide as similar species and situations come under scrutiny (cf., Baker et al. 1996). As an example, the existence of genetic baseline information of the structure of salmonid populations in the Pacific Northwest provided crucial information to determine appropriate decisions to "list" or "not to list" certain depleted stocks of fish under the Endangered Species Act (Waples et al. 1995). Similar information collected by the Trustee Council under projects 96196 and 96255 has already provided crucial information to better enable the conservation and sustained consumption of populations of pink salmon and sockeye salmon in the EVOS area.

NEED FOR THE PROJECT

A. Statement of Problem

Many of the vertebrate and invertebrate populations inhabiting the northeast coast of the Gulf of Alaska were affected by the oil spilled from the *Exxon Valdez*, but investigations into the extent of injury were often hampered by the lack of baseline data. In the years following the spill, Trustee Council-funded projects at the ADF&G Genetics Laboratory involved both the examination and mitigation of the effects of the spill. While several projects will be completed by the end of FY97, continuing projects will be relocated to the ASLC in Seward. Prior to this relocation, it is important that considerable time and effort be spent in preparation both to maintain project continuity as well as to identify areas for future collaboration between ADF&G, ASLC, and UAF.

Currently, ADF&G genetic studies are conducted at the Anchorage laboratory, sometimes at

various hatcheries across the state of Alaska, and now in five consulting laboratories in Nova Scotia, Washington, and Montana. Much of this dispersion occurred because of the paucity of wet lab and dry lab space available in the region. Consolidation of these projects into one project at the ASLC will increase efficiency and cost-effectiveness of the research.

The planning process in year one will include a review of current studies of the structure of marine populations and the applications of new conservation strategies for populations of species that occur in the spill area. The review will also focus on needs for genetics research generated by the Trustee Council's funding of numerous projects to rehabilitate or enhance salmon in the greater spill area. The funding of these projects, often proposed by third parties, drives the ADF&G permitting and monitoring process without the proper baseline information for decision making. The process of using *a priori* genetic information to conserve genetic diversity during restoration has already begun in the Pacific Northwest and California, partially as a response to Endangered Species Act listings (ESA, Waples 1995), and partially to provide a means for the states themselves to proactively identify appropriate management units, on a genetics basis, for sustained conservation (see Cloud and Thorgaard 1993 and papers therein; Busack and Shaklee 1995; Kostow 1995; Leider et al. 1995).

B. Rationale/Link to Restoration

Several Trustee Council-funded projects proposed to mitigate the effects of the *Exxon Valdez* oil spill on native populations of salmonid and other marine species through an array of management and restoration strategies (e.g., see Projects 96127, 96131, 96220, 96222, 96255, 96256, 96272). But, prior to the spill we knew little about the genetic structure of these native populations, and a better understanding of genetic structure of the species inhabiting the greater spill area is critical to their long-term management and conservation. We recognize that managing fisheries on too fine a scale may adversely affect the fishing industry and waste management resources; but managing on too large a scale may result in loss of genetic adaptations and diversity in the wild salmon populations. As funded, some of these projects may actually have long-term deleterious effects on the genetic diversity and sustainability of the resource intended for enhancement.

Also, knowledge gained from these projects conducted at the Alaska SeaLife Center is needed to correctly interpret and apply the findings obtained from ecosystem analyses (Trustee Council Project series 96320) on a population-by-population basis, more properly define the population-level nature of the injury documented in previous studies, and otherwise guide the decision-making process in the management and conservation of populations in the EVOS-affected area.

Finally, the same knowledge of population structure gained through this project will be used for more than planning and interpretation; it will be used for genetic monitoring and risk assessment needed to evaluate the supplemental restoration strategies above. This monitoring and risk assessment is analogous to the process currently being conducted to evaluate supplemental restoration of damaged populations on the Columbia River by the Northwest Power Planning Council (Waples et al. 1991; see Cuenco et al. 1993). The baseline

information provided by this project will be essential for any future study of the genetic effects on populations proposed for restoration and enhancement in the spill-affected area.

The following potential areas might benefit from future genetic investigation at the ASLC:

1. Pink salmon

Two current pink salmon projects will be supported by this project, *Genetic structure of Prince William Sound pink salmon* (Project 97196) and *Construction of a linkage map for the pink salmon genome* (Project 97190). Peer reviewers of Project 95196 recommended that future investigations include a low-level expansion to include populations in other regions within the spill area.

2. Sockeye salmon

The Trustee Council funded the *Kenai River sockeye salmon restoration* (Project 96255) project which successfully compiled a genetic baseline of Upper Cook Inlet sockeye salmon populations and developed its use as an important management tool. This major project is complete, but future investigations may include expanding the baseline to include populations in other regions in the spill area to address important issues. An important conservation issue is the decline of indigenous sockeye salmon stocks in Prince William Sound. *Exxon Valdez* funds (both civil and criminal) are being used to support fish culture projects and plan projects that may affect wild-stock diversity.

3. Chum salmon

Chum salmon are a species that is indigenous to the spill area that has received little attention from post-spill investigations. In order to apply mixed-stock analyses using genetic data to resolve interception questions, the ADF&G Genetics Laboratory has compiled an extensive genetic baseline from western and northwestern Alaska. Data from southcentral Alaska are sparse. Recent studies indicate that the contact zone between two major ancestral lineages lies within this region. Further sampling between these locations may more accurately locate the contact zone and determine if any introgression between lineages occurs.

4. Chinook salmon

While chinook salmon do not spawn within the Sound, spawning populations are found throughout the remaining spill area and are important to both the commercial and sportfishing industries within the spill area. Recent statewide genetic studies indicate a similar contact zone between major ancestral lineages somewhere within the spill area. Expanding the genetic baseline for chinook salmon would provide important information for management and conservation of these stocks.

5. Pacific herring

Genetic Discrimination of Prince William Sound Herring Populations (Project 96165) is

currently scheduled for completion in FY98. Depending on the results of this project, it may be necessary to continue investigations in herring genetics by further stratifying the sampling, extending samples over a broader area or extending samples over a broader time frame.

6. Trout and char

The recovery of cutthroat trout and Dolly Varden indigenous to the Sound is still uncertain. A current project, *Cutthroat trout and Dolly Varden: the relation among and within populations of anadromous and resident forms* (Project 96145) is investigating the relation between resident and anadromous forms using genetic, meristic and life history characteristics. Extension of this study to include the entire spill area would be valuable.

7. Rockfish

The recovery of rockfish is still uncertain. The status of species determination is indefinite and molecular systematics of these species is an important scientific question.

8. Birds and Mammals

Many adverse impacts were documented, but the understanding of population structure of birds and mammals in the spill area remains largely a mystery. The Trustee Council is only just attracting proposals to study the population genetics of some damaged bird species. The establishment of a core genetics facility will better enable principal investigators working at the ASLC to incorporate a genetics component to the study of population biology of affected species in the greater spill area.

C. Location

The research will be conducted at the Alaska SeaLife Center in Seward and the results will effect communities throughout the spill area that depend on the use of natural resources.

COMMUNITY INVOLVEMENT

Components of this proposal were driven by community request. ADF&G is currently grappling with the permitting of funded projects and the evaluation of potential restoration projects in the areas of Kodiak, Kenai Peninsula, and Chignik as well as Prince William Sound.

Also, the Seward Association for the Advancement of Marine Science (SAAMS) will be consulted to insure projects are consistent with the schedules and processes already in place. Wherever possible, local-hire will be used to fill positions required for both field sampling and routine laboratory positions, and ADF&G plans to participate in all of the educational and outreach programs scheduled for the Center.

PROJECT DESIGN

A. Objectives

1. Plan genetics integration into Alaska SeaLife Center operations and identify species and conservation issues in the EVOS area that need be addressed with genetic techniques.

2. After year one, conduct investigations into the genetic structure of species in the EVOS area. ADF&G will conduct studies on salmonids and other marine fishes approved through annual Trustee Council review.

3. Provide a core facility for genetic investigations of marine birds, mammals, invertebrates and other species in the spill area. Technologies available to principal investigators will include allozyme and PCR-based DNA analysis techniques. ADF&G will move an automated DNA sequencer to the ASLC to facilitate the DNA analyses.

4. Provide experimental runs of fish for use by visiting scientists for projects such as the *Construction of a Linkage Map for the Pink Salmon Genome* (Project 97190).

B. Methods

Year 1 of this study is limited to planning, identification of appropriate research directions, and review of historical information and studies. The results of this planning process will guide the investigators in developing proposal details for FY98.

Objective 1 and 2. *ADF&G studies*

During year 1, ADF&G scientists will review current studies of the structure of marine populations and the applications of new conservation strategies for populations of species that occur in the spill area. Review will also focus on elements of the Trustee Council restoration and enhancement projects that will benefit from genetics research and monitoring.

Objective 3. *Development of a core laboratory*

Plans for the genetics core laboratory will be reviewed and modified as needed. A presentation of the planned laboratory facilities will be made at the annual restoration meeting in January and input solicited from potential investigators. Administrative and logistic procedures for the core laboratory will be addressed.

Objective 4. *Development of experimental runs of fish*

A plan for implementing experimental runs of fish will be initiated and developed within the guidelines of the ADF&G. The plan will address: 1) species to be included, 2) source and timing of broodstocks, and 3) schedule for developing the runs. As with the core laboratory, input from potential collaborative investigators will be solicited.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Seward Association for Advancement of Marine Science; Institute of Marine Science (IMS)

SCHEDULE

A. Measurable Project Tasks for FY97

September - December 1997:	Literature review and interviews with management personnel, research personnel and community users
January 22 - 25, 1997:	Attend Annual Restoration Workshop
January - March 1997:	Compile list of potential species issues; prepare plan to accomplish project relocation
February - April 1997:	Draft report for FY97
September 1997:	Annual report for FY97

B. Project Milestones and Endpoints

January 1997:	Memo on literature review and interviews, Restoration Workshop Presentation
March 1997:	Memo on potential species issues and project relocation plan
September 1997:	Final report for FY97

C. Completion Date

7 years

PUBLICATIONS AND REPORTS

Annual Reports, annual reporting of significant findings in the peer-reviewed literature

PROFESSIONAL CONFERENCES

None in year one

NORMAL AGENCY MANAGEMENT

This project is not required of ADF&G by statute or regulation.

ADF&G spends approximately $500.0K from State of Alaska general funds annually on genetics studies. For this proposed project, salaries and benefits of principal investigators J. Seeb and L. Seeb are fully covered by these general funds. These funds also support the basic operation of and enhancements to the Anchorage genetics laboratory for ADF&G management projects as well as EVOS projects.

Commercial Fisheries Management and Development Division scientists perform management-oriented studies to identify conservation units of commercially important resources at the direction of the Director. Funds are limited and generally restricted to major contentious issues facing the Board of Fisheries.

The Trustee Council has funded genetic study of injured resources at levels approaching $1,000.0K during many years post-spill. These major projects resulted in an improved knowledge of fisheries resources and provided permanent improvements to resource management.

This project is designed to be a restructuring of these major, short-lived projects into a longer-term project with several minor elements addressing population genetics issues in the spill area. Elements will be modified annually to address population issues identified through collaborative research at the Alaska SeaLife Center. Additionally, this project offers core genetics analyses to other principal investigators at the SeaLife Center and provides experimental fish runs for long-term research.

Year three and beyond project costs are estimated based upon placement of approximately six staff at the ASLC to maintain runs of anadromous fish, operate the core facility, and conduct the minor research elements ($350.0K). The remaining annual cost ($96.0) is estimated based upon an $2.00/ft^2 projection of facilities rent for 4000 ft^2 of wet lab, dry lab, and offices. None of these project components can or would be funded by ADF&G as normal agency management.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Efforts will be coordinated through regional and area staff of ADF&G as appropriate to design genetics studies that guide the Trustee Council restoration projects, especially those that involve stocking or transport of fish. Special effort will be expended to coordinate with and offer use of the core facility to IMS faculty and NOAA and NBS staff that conduct research at the Alaska SeaLife Center in Seward.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This is a new project.

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1991- Affiliate Associate Professor, University of Alaska Fairbanks
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SELECTED PUBLICATIONS:

Seeb, J.E., L.W. Seeb, and F.M. Utter. 1986. Use of genetic marks to assess stock dynamics and management programs for chum salmon. Trans. Amer. Fish. Soc. 115:448-454.

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1991-	Statewide Geneticist, ADF&G, Anchorage
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1978-1981	Fish Geneticist, Pacific Fish. Research, Olympia WA
1977-1979	Geneticist, National Marine Fisheries Service, Seattle

SELECTED PUBLICATIONS:

Wishard, L. N., J. E. Seeb, F. M. Utter, and D. Stefan. 1984. A genetic investigation of suspected redband trout populations. Copeia 1984(1):120-132.

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LITERATURE CITED

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Waples, R.S. 1995. Evolutionarily significant units and the conservation of biological diversity under the Endangered Species Act. Pages 8-27 in J.L. Nielsen, editor. Evolution and the aquatic ecosystem: defining unique units in population conservation. American Fisheries Society Symposium 17, Bethesda, Maryland.

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997						
Personnel		$36.7						
Travel		$3.1						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$4.5	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$44.3	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
General Administration		$5.5						
Project Total	$0.0	$49.8	$152.0	$446.0	$446.0	$446.0	$446.0	
Full-time Equivalents (FTE)		0.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Figures for FY98 and beyond include $49,000 for estimated Alaska SeaLife Center rent. Actual amount will change to reflect final decision about rent.

1997

Prepared:

Project Number: 97252
Project Title: Alaska SeaLife Center Investigations of Genetically Important Conservation Units of Species in the EVOS Area
Agency: ADF&G

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/16/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1997
Vacant	FB III	18K	6.0	6,123		36.7
	Subtotal		6.0	6123.0	0.0	
					Personnel Total	$36.7

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
8 Round trips to area offices in Cordova, Kodiak, Seward and Homer	200	8			1.6
10 days per diem at 150/day			10	150	1.5
				Travel Total	$3.1

1997

Prepared:

Project Number: 97252
Project Title: Alaska SeaLife Center Investigations of Genetically Important Conservation Units of Species in the EVOS Area
Agency: ADF&G

FORM 3B
Personnel
& Travel
DETAIL

4/16/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Contractual Costs:	Proposed
Description	FFY 1997
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FFY 1997
Commodities Total	$0.0

1997

Prepared:

Project Number: 97252
Project Title: Alaska SeaLife Center Investigations of Genetically Important Conservation Units of Species in the EVOS Area
Agency: ADF&G

FORM 3B
Contractual & Commodities DETAIL

4/16/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
Computer	1	4.5	4.5
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$4.5

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1997

Project Number: 97252
Project Title: Alaska SeaLife Center Investigations of Genetically Important Conservation Units of Species in the EVOS Area
Agency: ADF&G

FORM 3B
Equipment
DETAIL

Prepared: 4/16/96

THE FACTORS THAT LIMIT SEABIRD RECOVERY IN THE EVOS STUDY AREA: A MODELING APPROACH SUBMITTED UNDER THE BAA

Project Number: 97253-BAA

Restoration Category: Research

Proposer: H.T. Harvey & Associates

Lead Trustee Agency:

Cooperating Agencies:

Alaska SeaLife Center:

Duration: 1st year, 1-year project

Cost FY 97:

Geographic Area: No field work anticipated

Injured Resource/Service: All seabird species being considered by APEX

ABSTRACT

We propose to use models to assess ways in which food supply could be affecting recovery of seabirds in the EVOS study area. We will develop models of foraging effort and success as it relates to breeding productivity. Results will test the degree to which food limitation is affecting recovery, indicate the mechanisms by which this could come about, and identify the scale at which interactions are occurring between food availability and the colonies being studied by APEX. Moreover, results should help to "aim" the APEX research effort so that sufficient data are collected to fulfill the overriding APEX objective: to understand the ways in which food supply is limiting seabird recovery.

INTRODUCTION

The APEX Project underway in Prince William Sound is based on the assumption that reduced food supply during the chick provisioning period of seabird reproduction is slowing the recovery of seabird populations from mortality incurred during the *Exxon Valdez* oil spill (EVOS). This assumption has precedent, in that it was argued to be the case for similar species at the same latitude nesting around the British Isles (Furness & Birkhead 1984, Cairns 1989; see below). However, the assumption has not been tested among the Prince William Sound colonies and, as shown by Furness & Birkhead (1984) and Ainley et al. (1995), geographic scale figures importantly in the way that the effect could come about.

We propose here to use models to assess the ways in which food supply could be affecting recovery. For seabirds nesting in the EVOS study area, we will develop models of foraging effort and success as it relates to breeding productivity. Results not only will test the degree to which the assumption of food limitation is valid, but will indicate the scale at which researchers should be assessing interactions between food availability and the colonies being studied. Moreover, results also should provide ways to "aim" the APEX research effort so that sufficient data are collected to provide input into the overriding APEX objective: to understand the ways in which food supply is limiting recovery of seabirds in the EVOS study area. Our work will be based on existing data (e.g. the Alaska Seabird Colony Register) and certain results of ongoing APEX studies (e.g. foraging range of affected species in the region). We will work closely with APEX PIs, soliciting their input in all phases of our effort.

NEED FOR THE PROJECT

A. Statement of Problem

The factors that affect the size or growth of seabird populations are complex and more than one mechanism may be involved. It has been theorized, in general, that the size (and therefore the growth, too) of a seabird population in a region is affected by food supply during breeding and/or nesting space; influencing population growth, as well, are the contributions of density-dependent mortality during the non-breeding season (a function also of food supply) and social factors related to colonial nesting (Birkhead & Furness 1985; Cairns 1989, 1992). In some cases nesting space appears to be the more important ultimate factor (e.g., Duffy 1983; Ainley & Boekelheide 1990) and in others it is argued that food is the more important, especially during the chick provisioning period (e.g., Ashmole 1963, 1971; Furness & Birkhead 1984, Cairns 1989).

The geographic structure or distribution of a seabird population in a region (i.e., the size and spacing of colonies) is also affected by availability of nesting habitat and food (Furness & Birkhead 1984, Cairns 1989). These resources are allocated by an interplay

of forces, both "positive" (favoring coloniality) and "negative" (favoring solitary living) (Ainley et al. 1995). As summarized by Wittenberger & Hunt (1985) and Burger & Gochfeld (1990), negative forces, such as interference and exploitative competition, counter the positive ones, such as group defense against predators and facility in gaining mates. If the size distribution of colonies is stable, this implies both sets of forces to be at work. Negative forces, mediated proximally through emigration to colonies with more favorable conditions or establishment of new colonies, act on colony size through a negative feedback loop: the greater the colony size, the greater the impact of negative forces, thus, encouraging a reduction in colony size. Positive factors, in contrast, result in positive feedback: to new recruits, high density areas are the most attractive. If positive forces are sufficiently strong relative to negative ones, new colonies would not be established.

Among temperate seabirds, Furness & Birkhead (1984) and Cairns (1989) found an inverse relationship between number of breeding adults in a given colony and number of conspecific adults from other colonies nesting within foraging range of the reference colony. They concluded that the pattern resulted from competition for food among parents as a result of prey depletion and, therefore, that food supply was limiting ultimate population size in the region. In addition, Furness & Birkhead predicted that prey depletion could not explain the size and distribution of polar seabird colonies owing to the more abundant food supply in polar regions. Ainley et al. (1995) confirmed that prey-depletion by foraging parents cannot explain the geographic patterns observed among penguins in the southern polar region. These authors concluded that penguin populations were indeed structured geographically but that any explanation of the pattern must incorporate the role of philopatry among recruits, as well as the extent of overlap in foraging areas as argued by Furness & Birkhead (1984) and Cairns (1989).

The factors that affect geographic structure and, ultimately, total population size come to bear when new colonies are formed or depleted ones re-established. Many studies of seabirds have found that when breeding density at large colonies is high, prospectors are more likely to settle at smaller colonies nearby, thus, increasing the emigration rate from the central colony and increasing growth rate of small colonies (Potts 1969, Potts et al. 1980, Birkhead 1977, Coulson et al. 1982, Coulson 1991). Conversely, small colonies decrease more rapidly than larger colonies, as demonstrated in studies of kittiwakes *Rissa* sp. (Coulson 1983) and murres *Uria* sp. (Takekawa et al. 1990). Additionally, inverse relationships between colony size and breeding success and chick growth also provide indirect evidence for food limitation (studies of murres: Hunt et al. 1986, Gaston et al. 1983).

B. Rationale/Link to Restoration

The APEX project should provide much insight about the ecological processes that affect the well being, growth, and size of seabird populations in Prince William Sound and Cooke Inlet (EVOS study area). However, the project's underlying assumptions need to

be fully tested so that the mechanisms by which food limitation is affecting population growth can be fully appreciated and to insure that sufficient data on pertinent aspects of seabird life history are being collected so that, in the end, an integrated explanation of population limitation is available. A meaningful way by which to carry out this test is to use models.

C. Location

The data used in the modeling will come from Prince William Sound and Cooke Inlet as a result of the APEX project and other efforts such as the Alaska Seabird Colony Register. Our effort will be conducted on computers at our home offices. The benefits of the project will be realized in the EVOS area, as results will help to direct restoration of seabird colonies there.

COMMUNITY INVOLVEMENT

All communities affected by the APEX project will be involved indirectly in the proposed work.

PROJECT DESIGN

A. Objectives

Hypotheses to be evaluated by exploratory modeling using existing data:

1. Under the null hypothesis, the distribution and relative size of adjacent colonies of kittiwakes, murres, and pigeon guillemots in the EVOS study area, and in that general region of Alaska, fail to indicate that food supply is affecting overall population size. We hypothesize that a negative relationship should exist between the size of a colony and the total number of breeding adults at colonies within the foraging range of the reference colony.

2. Under the null hypothesis, foraging range, feeding frequency of chicks, and reproductive success is not related to colony size. We hypthosize that feeding frequency of chicks and breeding success in large colonies should be lower than in small colonies.

3. Finally, we hypothesize that no differences in 1 and 2 will be evident in pre- and post-spill comparisons, where possible.

B. Methods

We will be keying analyses on APEX species and those identified as not recovering (kittiwake, murres, pigeon guillemots). We will consider marbled murrelets, but recognize the problematic nature of acquiring data on the natural history of this species.

To use models in order to test Hypothesis 1, we will require the following data:

- Distribution and sizes of colonies
- Coastline and bathymetry
- Bird distributions at sea in the study area.

Most of these data already exist in digital form. As a result of previous studies, including the Alaska Seabird Colony Register and damage assessment from the EVOS and analysis of pelagic distributions for USFWS and NBS, Ecological Consulting (Inc) is in possession of many of these data in GIS format. We will use the statistical methods used by Furness & Birkhead (1984), Cairns (1985), and Ainley et al. (1995). In brief, we will determine the amount of foraging habitat adjacent to each colony (using bathymetry and perhaps the juxtaposition of persistent ocean fronts if visible in infrared imagery) and the distance between adjacent colonies. We will total the sizes of all colonies within radii of increasing size of each colony. Using statistical correlation, at the maximum foraging range of a species, an inverse relationship should exist between the size of a colony and the total size of all other colonies. As much as possible, we will compare the geographic structure of seabird colonies over time and, especially, before and after the oil spill.

To test Hypothesis 2, we will be constructing models of demography and foraging energetics as related to breeding success, as follows.

Demographic Analysis. Demographic and reproductive data from colonies that are not recovering will be used to determine those aspects of colony performance that are having the most significant effect in delaying or preventing recovery. Where data are available, we will construct simple life table models of pre- and post-spill colonies to determine which demographic factors contribute the most to declining (or not growing) colony sizes. This analysis will help to determine when and on what age-class the effects of food limitation would be most significant, and help to provide further insight into the mechanism(s) underlying poor colony performance.

Foraging Energetics and Breeding Success. Understanding the linkage between food availability and breeding success is critical to formulating a model that can predict the effect of perturbations of food supply on seabird populations. These relationships were modeled in detail by Ford et al. (1982) for oil spill-induced perturbations of murre and kittiwake populations on the Pribilof Islands. This model concluded that the effects of direct adult mortality during an oil spill were of greater significance than the concurrent reduction in food supply, but did not address the effects of long-term

decreases in food availability. We would take a more empirical approach for this study, relaying on data from ongoing and future studies in Prince William Sound and the Gulf of Alaska (APEX). Emphasis would be placed on describing the relationship between the quantity and quality of food delivered to the chicks and subsequent reproductive success, and the relationship between food availability and delivery rates. We expect that this analysis will reveal data gaps relating to the linkage between food availability, breeding success and population growth, and that these findings may provide guidance for subsequent field studies.

Providing Input to the APEX Ecosystem Model. Seabird populations are important components of North Pacific marine ecosystems. Many of the data that would be required to estimate the impact of seabirds on lower trophic levels are already available. Predicting the effects that perturbation of lower trophic levels would have on seabird populations is more problematic. Such predictions will require understanding of the linkage between food availability in terms of the distribution, timing, and nature of the food supply, and the quantitative effect that this will have on various aspects of reproductive success. Establishing the exact nature of these relationships is beyond the scope of our study, but we will be able to determine what factors appear to be the most critical, and help to target ongoing research programs toward this goal.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The proposed analysis will be conducted by individuals from private institutions. However, PI's will consult frequently with the biologists from Trustee agency who are collecting the data in the APEX project. Agency personnel will likely be co-authors of the reports or publications prepared.

SCHEDULE

A. Measurable Project Tasks for FY 97 (October 1, 1996 - September 30, 1997)

Oct. 1- December 31:	Assemble data resulting from APEX during FY 95 and FY96, from pre- and immediately post-spill studies, and from the Alaska Seabird Colony Register.
January 22-25:	Attend annual Restoration Workshop.
February 1 - 30 June:	Continue to assemble data; assess seabird population geographic structure.
1 July - 31 August:	Construct models of seabird foraging effort/breeding productivity.
1 - 30 September:	Finish final report for review.

Winter 1997-98:	Revise final report.

B. Project Milestones and Endpoints

30 June 1997:	Report on geographic structure of seabird populations in southern Alaska.
30 September 1997:	Final report, with foraging/energetic model.
January 1998:	Present papers at annual meeting of Pacific Seabird Group: *(1) The geographic structure of seabird populations in southern Alaska: relationship to food supply and EVOS; (2) A foraging/energetic model to explain lack of recovery of Prince William Sound seabirds.*
15 April 1998:	Submit final version of final report.
Spring 1998:	Submit two papers for publication in either *Condor, Auk* or *Colonial Waterbirds.*

C. Completion Date

A draft final report will be available by 30 September 1997.

PUBLICATIONS AND REPORTS

Besides a final report, we anticipate two publications as identified above under Milestones and Endpoints.

PROFESSIONAL CONFERENCES

We anticipate presenting two papers, as identified under Milestones and Endpoints, at the annual meeting of the Pacific Seabird Group in winter 1997-98.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project depends fully on integration with almost all studies in the APEX project.

PROPOSED PRINCIPAL INVESTIGATORS

Dr. David G. Ainley
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Dr. R. Glen Ford
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PERSONNEL

David G. Ainley, PhD, has investigated the ecology of seabirds for 25 years, having conducted studies in Alaska, California, Mexico, Hawaii and Antarctica. Much of his research has involved the species of seabirds affected by EVOS, especially guillemots and murres. He has published over 125 scientific papers and has authored three books and 2 monographs. With Glen Ford, he participated in development of demographic models to assess impacts of catastrophic events on seabird populations in California (for NOAA, Gulf of the Farallones National Marine Sanctuary).

Selected Ainley Publications

Ainley, D.G. & R.J. Boekelheide (eds.). 1990. Seabirds of the Farallon Islands: Ecology, Structure and Dynamics of an Upwelling System Community. Stanford University Press, Palo Alto. 425 pp.

Ainley, D.G. N. Nur & E. J. Woehler. 1995. Factors affecting the size and distribution of pygoscelid penguin colonies in the Antarctic. Auk 112: 171-182.

Ainley, D.G., L.B. Spear & S.G. Allen. In press. Temporal and spatial variation in the diet of the Common Murre in California. Condor.

Ainley, D.G., W. J. Sydeman, S. A. Hatch & U. W. Wilson. 1994. Seabird population trends along the west coast of North America: causes and the extent of regional concordance. Studies Avian Biol. 15: 119-133.

Ainley, D.G., W. J. Sydeman, R. H. Parrish & W. R. Lenarz. 1993. Oceanic factors influencing distribution of young rockfish (*Sebastes*) in central California: a predator's perspective. Calif. Coop. Ocean. Fish. Investig., Repts. 34: 133-139

R.Glen Ford, PhD, was trained in mathematical ecology at University of California, Berkeley, and has been investigating the quantitative ecology of seabirds for the past 20 years, especially in regard to species of the eastern North Pacific, Gulf of Alaska and Bering Sea. He is well versed in GIS applications, having developed software that has been used widely by marine ornithologists, including those studying marbled murrelets in Alaska. He has modeled impacts of oil spills to marine bird populations and conducted computer simulations of the response of seabirds to perturbations in their food supply. Dr. Ford has authored 23 scientific papers (and 28 reports), including 11 on marine birds.

Selected Ford Publications

Ford, R.G., J.A. Wiens, D. Heinemann & G.L. Hunt, Jr. 1982. Modeling the sensitivity of colonially breeding marine birds to oil perturbation. J. Appl. Ecol. 19:1-31.

Ford, R.G., M.L. Bonnell, D.H. Varoujean, G.W. Page, H.R. Carter, B.E. Sharpe, D. Heinemann & J.L. Casey. 1996. Total direct mortality of seabirds from the *Exxon Valdez* oil spill. In: B.Wright, J. Rice, R. Spies & D. Wolfe (eds.) Am. Fish. Soc. Symposium, Vol. 18 (in press).

Nur, N., R.G. Ford & D.G. Ainley. 1993. Computer model of Farallon seabird populations. Final Report, Gulf of the Farallones National Marine Sanctuary, San Franciso.

Piatt, J.F. & R.G. Ford. 1993. Distribution and abundance of Marbled Murrelets in Alaska. Condor 95:662-669.

Wiens, J.A., R.G. Ford, D. Heinemann & C. Fieber. 1978. Simulation of marine bird population energetics, food consumption, and sensitivity to perturbation: Pribilof Islands. In: Environmental Assessment of the Alaskan Continental Shelf. Annual Reports 2: 1-83.

David C. Schneider, PhD, has been involved in a number of studies on the distribution of seabirds in relationship to marine features and has constructed bioenergetic and carbon models to assess the role of seabirds in nutrient cycling in the Bering Sea, Benguela Current, and elsewhere. He has authored over 50 publications, including the recently published book: *Quantitative Ecology: Spatial and Temporal Scaling.* Currently, he holds a position at the Institute of Cold Ocean Science, Memorial University, Newfoundland.

Selected Schneider Publications

Schneider, D.C. 1995. Spatial and temporal scaling of energy flux through populations of marine nekton. Pp. 419-428 in (E. Runde & K.J. Erikstad, eds.) Ecology of Fjords and Coastal Waters. Elsevier, Amsterdam.

Schneider, D.C. 1994. Scale-dependent spatial dynamics: marine birds in the Bering Sea. Biol. Reviews 68:579-598.

Schneider, D.C. & V.P. Shuntov. 1993. The trophic organization of marine birds in the Bering Sea. Rev. Fish. Sci. 1:311-335.

Schneider, D.C. 1992. The thinning and clearing of prey by predators. Amer. Natur. 139:148-160.

LITERATURE CITED

Ainley, D.G., N. Nur & E.C. Woehler. 1995. Factors affecting the distribution and size of penguin colonies in the Antarctic. Auk 112: 171-182.

Ainley, D.G. & R.J. Boekelheide. 1990. Seabirds of the Farallon Islands: Ecology, Structure and Dynamics of an Upwelling-System Community. Stanford Univer. Press, Stanford, CA.

Ashmole, N.P. 1963. The regulation of numbers of tropical oceanic birds. Ibis 103b:458-473.

Ashmole, N.P. 1971. Seabird ecology and the marine environment, pp. 223-286 in (D.S. Farner & J.R. King, eds.) Avian Biology Vol. 1. Academic Press, NY.

Birkhead, T.R. & R.W. Furness. 1985. The regulation of seabird populations, pp. 145-167 in (R.M. Sibly & R.H. Smith, eds.) Behavioural Ecology. Blackwell, Oxford.

Burger, J. & M. Gochfeld. 1990. The Black Skimmer: Social Dynamics of a Colonial Species. Columbia Univer. Press, New York.

Cairns, D.K. 1989. The regulation of seabird colony size: a hinterland model. Amer. Nat. 134:141-146.

Cairns, D.K. 1992. Population regulation of seabird colonies, pp. 37-61 in (D.M. Power, ed.) Current Ornithology, Vol. 9. Plenum Press, NY.

Duffy, D.C. 1983. Competition for nesting space among Peruvian guano birds. Auk 100:680-688.

Ford, R.G, J. A. Wiens, D. Heinemann & G.L. Hunt, Jr. 1982. Modeling the sensitivity of colonially breeding marine birds to oil spills: guillemot and kittiwake populations on the Pribilof Islands, Bering Sea. J. Appl. Ecol. 19:1-31.

Furness, R.W. & T.R. Birkhead. 1984. Seabird colony distributions suggest competition for food supplies during the breeding season. Nature 311:655-656.

Gaston, A.J., G. Chapdelaine & D.G. Noble. 1983. The growth of Thick-billed Murre chicks at colonies in Hudson Strait: inter- and intra-colony variation. Can. J. Zool. 61:2465-2475.

Hunt, G.L., Jr., Z.A. Eppley & D.C. Schneider. 1986. Reproductive performance of seabirds: the importance of population and colony size. Auk 103:306-317.

Lack, D. 1954. The Natural Regulation of Animal Numbers. Clarenden, Oxford, UK.

Potts, G.R. 1969. The influence of eruptive movements, age, population size and other factors on the survival of the Shag (*Phalacrocorax aristotelis* L.). J. Anim. Ecol. 38:53-102.

Potts, G.R., J.C. Coulson & I.R. Deans. 1980. Population dynamics and breeding success of the Shag *Phalacrocorax aristotelis*, on the Farne Islands, Northumberland. J. Anim. Ecol. 49:465-484.

Takekawa, J., H.C. Carter & T.E. Harvey. 1990. Decline of the Common Murre in Central California, 1980-1986, pp. 149-163 in (S.G. Sealy, ed.) Auks at Sea. Studies in Avian Biology, Cooper Ornithol. Soc., Berkeley, CA.

Wittenberger, J.F. & G.L. Hunt, Jr. 1985. The adaptive significance of coloniality in birds, pp. 1-79 in (D.S. Farner, J.R. King & K.C. Parkes, eds.), Avian Biology, Vol. 8. Academic Press, NY.

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Personnel		$29,584.0						
Travel		$6,720.0						
Contractual		$49,880.0						
Commodities		$1,500.0						
Equipment		$0.0						
Subtotal	$0.0	$87,684.0						
Indirect								
Project Total	$0.0	$87,684.0						
Full-time Equivalents (FTE)		2.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1997

Prepared: 1 of 4

Project Number: 97253-BAA
Project Title: Factors that limit seabird recovery: a modeling approach
Name: H.T. Harvey & Associates

FORM 4A
Non-Trustee
SUMMARY

4/12/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FFY 1997
D. Ainley	Co-PI		2.0	12900.0		25,800.0
S. Terrill	Company Principle		0.1	18920.0		1,892.0
Graphic artist			0.1	9460.0		946.0
Admin. support			0.1	9460.0		946.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.3	50740.0	0.0	
					Personnel Total	$29,584.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
SFO-Anchorage	1000.0	2	12	125.0	3,500.0
SFO-Portland	200.0	2	4	110.0	840.0
SFO-St.Johns, NFLD	1000.0	1	2	110.0	1,220.0
Sci Meeting	250.0	2	6	110.0	1,160.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$6,720.0

1997

Project Number:
Project Title: Factors that limit seabird recovery: a modeling approach
Name: H.T. Harvey & Associates

FORM 4B
Personnel
& Travel
DETAIL

Prepared:

4/12/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Contractual Costs:		Proposed
Description		FFY 1997
Subcontract: ECI, Glen For , 3.0 mo @ 12,900/mo	38,700	
GIS Tech, 0.5 mo @ $9460/mo	4730	43,430.0
Memorial Univ., D.C. Schneider, 0.5 mo	$12,900/mo	6,450.0
	Contractual Total	$49,880.0

Commodities Costs:	Proposed
Description	FFY 1997
Publication costs	1,500.0
Commodities Total	$1,500.0

1997

Prepared:

Project Number:
Project Title: Factors that limit seabird recovery: a modeling approach
Name: H.T. Harvey & Associates

FORM 4B
Contractual & Commodities DETAIL

4/12/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
NONE			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units

1997

Prepared: 4 of 4

Project Number:
Project Title: Factors that limit seabird recovery: a modeling approach
Name: H.T. Harvey & Associates

FORM 4B
Equipment
DETAIL

4/12/96

DELIGHT AND DESIRE LAKES RESTORATION PROJECT

Project Number:	97254
Restoration Category:	General Restoration
Proposer:	Lower Cook Inlet Fisheries Development Association. PO Box 2421, Homer, Alaska 99603. 907-235-4140
Lead Trustee Agency:	Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division and the Regional Limnology Laboratory, Soldotna.
Cooperating Agencies: Alaska SeaLife Center:	
Duration:	6 Years
Cost FY/97:	$129,300 Phase one.
Cost FY/98:	$96,100 Second Year if necessary.
Cost FY/99:	Phase two of the project would depend on the results of phase one (research & pre-fertilization study) and budget projections will be determined by the end of FY/98.
Cost FY/00:	
Cost FY/01:	
Geographical Area:	On the Outer Gulf Coast of The Kenai Peninsula on The Eastern Shore of McCarty Fiord of East Nuka Bay.
Injured Resource/Service:	Wild stock Sockeye Salmon and Commercial Fishing.

ABSTRACT

The proposed project would increase the quality of the rearing habitat through lake fertilization. Application of liquid fertilizer would increase the forage base for rearing sockeye salmon fry through nutrient enrichment. The expected result would be larger, younger and more numerous sockeye smolt with a corresponding increase in marine survival rates. The enrichment program would accelerate the recovery of the currently depressed wildstock sockeye salmon of Delight and Desire Lakes.

INTRODUCTION

The outer district of the Kenai Peninsula has many salmon stocks that are important to the region's wildstock salmon ecology as well as the areas local commercial salmon fishery. The Delight and Desire Lake sockeye salmon are the only wild sockeye salmon found in the outer district that are of commercial importance. Delight and Desire Lakes are located in the East Arm of Nuka Bay (McCarty Fiord) approximately 77.0 km southwest of Seward and 70 km. east of Homer (Figure 1&2). Both lakes are termed oligotrophic (a term describing lakes with low nutrient levels and are often poor in nitrogen, phosphorus and calcium). Delight lake is approximately 272 hectares in size with a maximum depth of 40 meters and Desire Lake is 162.5 hectares and the depth is unknown. Both lakes have outlet streams that empty into McCarty Fiord.

It has been documented that the *Exxon Valdez* Oil Spill caused heavy oiling to the beaches and near shore waters at the entrance to McCarty Fiord. Light oiling has been documented near the outlet streams of Delight and Desire Lakes (ADNR, 1989). Sockeye salmon and lost fishing time has been identified as injured resources and services respectively by the *Exxon Valdez* Trustee Council (EVTC).

The Delight and Desire Lake sockeye salmon stocks have historically supported a much higher annual catch in the East Nuka Subdistrict. Reduced fishing time may be demonstrated through the commercial sockeye catches of the East Nuka Bay Subdistrict. The commercial sockeye catch has averaged only 5,750 sockeyes annually since 1991 (the first year adult sockeye returned from the 1989 smolt outmigration). Prior to 1989, the 20 year average catch was 23,100 fish (Figure 3). In addition, Delight Lake has remained closed to commercial fishing since 1992 in an attempt to achieve the minimum escapement goal of 10,000 fish (ADF&G, 1994). The FY/96 work plan prepared by the *Exxon Valdez* Trustee Council lists sockeye salmon as an injured biological resource that is not recovering.

Recent Federal land transfers have resulted in Delight and Desire Lakes being transferred to the Port Graham Corporation. Pat Norman, president of the Port Graham Corporation, has advocated and supported this project through the Lower Cook Inlet Seiners Association and the Lower Cook Inlet Fisheries Development Association (Appendix A).

NEED FOR THE PROJECT

A. Statement of the Problem

The targeted resource is the wildstock sockeye salmon of Delight and Desire Lakes. Catches of sockeye salmon in the East Nuka Subdistrict have averaged only 5,750 fish since the first return of adult salmon after the 1989 oil spill. This compares to an average annual catch of 23,100 fish

for the years 1971 through 1990 (Figure 3). The Aialik Bay sockeye catch has also experienced similar results since 1991 (Figure 4). Aialik Bay is also located on the outer coast of the Kenai Peninsula approximately 20 km southwest of Seward and 32 km northeast of Delight and Desire Lakes (Figure 2). The beaches and near shore waters to the entrance of Aialik Bay, including the narrow passages and capes, were heavily oiled during the *Exxon Valdez* Oil Spill (ADNR, 1989). For the Aialik Subdistrict, during the years 1979 through 1990, the average annual catch is estimated to be 12,900 sockeyes, while the average catch since 1991 (the first year adult sockeye returned from the 1989 smolt outmigration) averaged only 1,600 sockeyes (Figure 4).

In addition to lost fishing time to the commercial fishery and inadequate adult escapements, is the possible effect that the sockeye salmon population decline may have on the sport fishery. Sport fishing effort has increased steadily for the past several years near the outlets of Delight and Desire Lakes. The eastern shore of East Nuka Bay is a popular location for sport fishing charter operations as well as a popular remote fly-in sport fishery.

The benefits realized from the lake enrichment project would help restore the wild stocks of sockeye salmon in Delight and Desire Lakes as well as increase, to former levels, the commercial catches of East Nuka Bay.

This proposal is constructed in two phases. Phase one (pre-fertilization phase) will last one year, two years depending on the results of the first year. Phase one would prepare a comprehensive limnological inventory and survey of Delight and Desire Lakes. Phase two would actually apply fertilizer for nutrient enrichment and would last an additional three years. The proposers realize that if phase one reveals that one or both of the lakes would benefit from nutrient enrichment, an additional financial source would be required to finance the annual cost of fertilization outside the time frame of this proposal. Currently, fishery enhancement projects in Lower Cook Inlet are financed by revenue generated by selling fish caught in special harvest areas. These areas, set up by the Cook Inlet Regional Aquaculture Association and the local commercial fishing fleet, are areas where fishermen can sell the fish they catch and use the revenue to fund annual fishery enhancement programs. By expanding the scope and revenue goal of one or more of these areas, additional revenue may be available to fund the annual fertilization costs. Eventually, increased escapements and decomposing carcasses may increase nutrient recycling and reduce annual fertilization requirements.

The lake enrichment program would not impact existing or future land and water uses. The liquid fertilizer used is designed to prevent eutrophication or over growth of algae in the lake and is not harmful to people or wildlife.

B. Rationale/Link to Restoration

Investigations were not performed to directly link oil spill injury to salmon survival (fry or adult) in the East Nuka Bay area and is often difficult to correlate oil spill damage to depressed salmon stocks. Mark Willette (ADF&G 1994) has found, however, that pink salmon fry growth rates were reduced when exposed to oil contamination for up to three years after the *Exxon Valdez* Oil Spill in the marine environment in Prince William Sound.

Although no definitive and absolute link to damage from the oil spill can be developed for the Delight and Desire Lakes sockeye salmon stocks, this restoration project has potential to accelerate the recovery of these currently depressed stocks. Lake enrichment would provide an increased forage base for rearing sockeye fry and could be expected to produce larger and more numerous sockeye smolt with increased marine survival rates.

For FY97, phase one of the restoration project will include research into the limnological characteristics of the lakes to determine feasibility to the proposed restoration plan. ADF&G guidelines mandate that a 1-2 year pre-fertilization study be conducted before commencing with any nutrient enrichment program. Objectives would include a comprehensive survey of physical and chemical characteristics, plankton abundance, and biological parameters of Delight and Desire Lakes. In addition, the spring and summer outmigration of sockeye salmon smolts would be monitored to assess size and age at emigration. This survey would be completed during the 1-2 year research and feasibility phase of the project and used to determine suitability of the lakes to nutrient enrichment.

Phase one of the project (research and monitoring) would determine the feasibility and the potential that Delight and Desire Lakes have to lake enrichment as well as the make up, amount and where and when to apply the fertilizer. The first phase would also determine the capability that the restoration action has to accelerate recovery of the depressed stocks. The ultimate objective of this project (**phase two**) is to restore production of adult sockeye salmon to pre spill levels by producing larger, younger and more numerous smolts.

B. Location

Delight and Desire Lakes are located in the East Arm of Nuka Bay (McCarty Fiord) on the Eastern Kenai Peninsula approximately 77.0 km southwest of Seward and 70 km east of Homer (figure 2). Communities that would benefit from the proposed project include the villages of Port Graham, Nanwalek and Seldovia as well as Homer and Seward. Sport fishers statewide may benefit by the increased numbers of returning fish.

COMMUNITY INVOLVEMENT

This project concept has been reviewed at the Lower Cook Inlet Seiners Association meeting in December 1995. Support for the project was unanimous as well as general support approved by the Villages of Port Graham and Nanwalek. Although no other public informational meetings on this project have been held at this time, it is anticipated that this sockeye salmon restoration project will create support from the general public in Lower Cook Inlet.

PROJECT DESIGN:

A. Objectives

Objectives of **Phase one** would include a thorough feasibility study of both lakes to determine suitability of one or both lakes for a nutrient enrichment program. The study would provide detailed assessments of the physical, chemical and biological aspects of the lakes so that lake enrichment criteria can be applied to determine if the lakes would benefit from the proposed fertilization project. **Phase one** of the project would follow the guidelines established by the Alaska Department of Fish and Game and the readers are referred to "Policy and Guidelines For Lake Fertilization" (ADF&G, 1979).

Limnological classifications have been developed by Koenings and Burkett (ADF&G, 1989) that classify lakes as recruitment-limited or rearing-limited with respect to which enhancement strategy would be appropriate. Considering their work and the limited work done on Delight and Desire Lakes by ADF&G in the early 1980's, the two lakes appear to be classified as rearing-limited. For example, the escapement levels prior to 1989, and spawning areas for both lakes do not appear to be the limiting factor restricting adult production. (ADF&G, 1994). In fact, juvenile sockeye production is not an exclusive function of spawner density in sockeye salmon nursery lakes but also includes a high quality rearing environment, Kyle, G. B. (ADF&G, 1994).

Koenings and Burkett (ADF&G, 1987a) have also linked one physical feature of lakes to the base of the food chain with respect to sockeye salmon production. That is the euphotic volume ([EV], the upper levels of the lake down to the effective light penetration for photosynthesis). Knowing the EV, sockeye fry/smolt production objectives can be established. From their work, Koenings and Burkett have developed a stocking model (110,000 spring juveniles, 23,000 smolts, 2,500 adults) that uses the number of EV units unique to each lake to estimate expected production. With the aforementioned model and classification we can proceed with the pre-enhancement study with the following defined objectives.

Lake selection criteria

1. Food supply must limit salmonid growth (rearing limited) during the fresh water rearing period life cycle during some or all of the growing period.

2. For nutrients to be available to the phytoplankton, the following should be fulfilled:
   A. The mean depth of the lake should be greater than the euphotic zone.
   B. The epilimnion should be less than twice the depth of the euphotic zone.
   C. The flushing rate of the epilimnion should have a flushing rate of a year or more.
   D. Shoreline should be steep with little vegetation.
   E. Light penetration should not limit primary production and turbidity should be low.

3. Nutrient enhancement is compatible with existing water usage.

4. ADF&G must be able to monitor, manage and evaluate the adult return.

5. Existing fry densities should be high enough (300-400 fry per hectare). Lower densities would increase costs.

6. Spawning areas should be large enough to accommodate increased number of spawners.

7. Predator numbers should not limit salmonid production.

Feasibility Sampling

The following parameters will be sampled and measured following procedures in the "Limnological Field and Laboratory Manual: Methods For Assessing Aquatic Production" (ADF&G, 1978).

1. Physical parameters
   A. Water flow
   B. Lake mapping for depth contours and volume estimates.
   C. Light penetration.
   D. Other factors such as temperature regimes and turbidity.

2. Chemical parameters
   A. Water sampling once per month and evaluated per limnological field and laboratory guidelines.

3. Biological parameters
   A. Primary production i.e.: phytoplankton sampling, should be done once per month.
   B. Secondary production i.e.: zooplankton sampling, should be done once per month.
   C. Tertiary production i.e.: adult salmon production is to be enumerated.

4. Determine the water residence time of Delight and Desire Lakes.

   Water discharge will be measured in the outlet streams twice during low, medium and high flow periods. Water level in the lakes will be measured at the same time and a relationship will be developed between the two variables to establish a flushing rate throughout the pre-fertilization phase.

Pre-Fertilization Study

The objectives of the pre-fertilization study involves the detailed monitoring of the physical, chemical and biological factors of the lake. Many of the objectives with the pre-fertilization study are similar to the objectives of the criteria used to select lakes for nutrient enrichment. The pre-fertilization phase will last a minimum of 1-2 years. The data base accumulated during the pre-fertilization study will be used to determine suitability of the lakes to nutrient enrichment and when phase two is implemented, the data base would be used to evaluate the success of the fertilization project.

Phase two (Lake Fertilization)

The goal of Alaska's lake enrichment program is to increase the zooplankton biomass without negatively altering the zooplankton species composition or changing the lake's oligotrophic state Kyle G. B. (ADF&G, 1994). The objectives of the Delight and Desire Lake enrichment program would not differ from those established by the Department of Fish and Game. The objectives, through lake fertilization, would develop a higher quality rearing environment and increase smolt production.

Based on the results of phase one (pre-fertilization study) a prescribed amount of liquid fertilizer (mg P/m^2/week) would be applied to all or a particular area of the lake surface either by aircraft using a crop duster technique or by a boat and pump system. The application period would likely commence when the water temperature reaches 5^0 C (June 1st-10th) and last until approximately September 1. For a remotely located area such as Delight and Desire Lakes, aerial application would be the least expensive, if topographically safe for aircraft.

B. Methods, Phase one (lake selection and pre-fertilization phase)

Methodology of **phase one** of the project would follow the guidelines established by the Alaska Department of Fish and Game and the readers are referred to "Policy and Guidelines For Lake

Fertilization" (ADF&G, 1979) and "Limnological Field and Laboratory Manual: Methods For Assessing Aquatic Production" (ADF&G, 1978). In addition, all proposed sampling schemes and survey programs will be reviewed and approved by the limnology section of ADF&G. The proposers assume that the lead agency, ADF&G, will manage and implement the project.

1. Lake selection criteria.
   Methodology for the lake selection criteria will be the same as the methods used for the feasibility sampling, pre-fertilization and fertilization phase outlined in the following:

2. Feasibility Sampling.
   All methodology to sample and measure the following parameters will follow "Limnological Field and Laboratory Manual: Methods For Assessing Aquatic Production"

   Physical parameters
   - A. Water flow.
   - B. Lake mapping for depth contours and volume estimates.
   - C. Light penetration.
   - D. Other factors such as temperature regimes and turbidity.

   Chemical parameters
   - A. Water sampling once per month during the ice-free period and evaluated per limnological field and laboratory guidelines. Parameters to be sampled include:

Alkalinity	Metals
Keljdahl nitrogen	Ammonium
Nitrate	Particulate phosphorus
Particulate nitrogen	Dissolved oxygen
Nitrite	Dissolved solids
Reactive phosphorus	Specific conductance
Reactive silica	pH
Total phosphorus	

Biological parameters
- A. Primary production: phytoplankton sampling, should be done every four weeks during the ice-free period.

B. Secondary production: zooplankton sampling, should be done once per month. Zooplankton are to be identified, counted and wet and dry weights determined

C. Tertiary production: adult salmon production is to be enumerated.
- Enumeration of fry and rearing juveniles to be made by tow netting and/or acoustical methods.
- Smolt and adult enumeration would be made by appropriate means i.e.: weir and fyke net.
- Salmonid viral and bacterial diseases would be monitored.

D. Determination of the following factors will be made:
- Smolt and adult enumeration will include age-weight-length data.
- Beach spawning areas will be estimated.
- Stomach of juvenile salmon would be collected and identified to determine food preferences.
- Information necessary to determine fecundity and egg-fry, fry-juvenile, and juvenile-smolt survival is to be collected.

E. Other Determinations
- The entire fertilization project and design will be reviewed by the Alaska Department of Fish and Game, Limnology Section.
- A public awareness program conducted to inform interested people of the potential of the lake enrichment program.

Methods, Phase two (Lake Fertilization)

Results of the lake selection and pre-fertilization phase will determine the amount, type (ratio of Phosphorus to Nitrogen, P:N) the rate which the fertilizer will be applied and the area of the lake to be covered. Since only very limited limnological survey work has been done on Delight and Desire Lakes to date, exact methodologies for the fertilizer application cannot be developed until the phase one inventories and surveys have been completed. The Cook Inlet Seiners Association has worked in cooperation with ADF&G on the Leisure and Chenik Lake fertilization program for several years. Results from the Leisure Lake project and the euphotic volume (EV) model developed by Koenings and Burkett indicate methodologies and procedures could be developed for the Delight and Desire Lake fertilization project.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The Lower Cook Inlet Fisheries Development Association assumes that the lead agency with the specific expertise (ADF&G) will implement the project.
Currently, the only contracts anticipated with the private sector would be contractual services with local air taxi services.

Contractual services would be arranged with the Limnology Laboratory of ADF&G to analyze all limnology samples, i.e., water and plankton samples. In addition, fertilizer procurement would be arranged through bid contracts with private vendors.

SCHEDULE:

A. Measurable Project Tasks For FY/97 (October 1, 1996 - September 30, 1997)

Project tasks for FY/97 would complete a comprehensive chemical, physical and biological survey of Delight and Desire Lakes as part of phase one (lake selection and pre-fertilization study). The surveys would begin as soon as ice is off the lakes (early May). A smolt enumeration camp would be stationed at both lakes. Lake sampling would be conducted in conjunction with the smolt project and continue through October or as directed by ADF&G, Limnology staff.

The following schedule is anticipated beginning in the spring of 1997.

Start-up to April 15:..... Arrange logistics (camp, boats, sampling equipment and consult with land owners).
April 16 to July 1..... Establish smolt evaluation camp and conduct limnology surveys.
July 2 to October 1..... Conclude spring, summer, fall limnology surveys and evaluate smolt data.
April 1998.....Annual report on 1997 lake survey results.

B. Project Milestones and Endpoints

Start-up to October 1997.....Complete 1st year lake feasibility and pre-fertilization surveys.
October 97 to April 1998.....Complete data analysis of lake feasibility and pre-fertilization surveys.
April 1998 to October 1998.....Complete 2nd year lake feasibility and pre-fertilization surveys.
October 98 to April 1999.....Complete 2nd years survey data analysis and determine fertilizer application rates, amounts and formula.
June 1999 to Sept. 99.....Apply fertilizer and continue lake limnology surveys.
October 1999 to April 2000.....Analyze lake survey data and evaluate lake enrichment project.
June 2000 to Sept. 2000.....Continue with lake enrichment program
Sept. 2000 to April 2001.....Analyze 2nd year lake enrichment program.

C. Completion Date

PUBLICATIONS AND REPORTS

There are currently no plans to submit manuscripts in FY/97. The first year of this project consists primarily of monitoring and data gathering.

PROFESSIONAL CONFERENCES

There are no plans to attend or participate in professional conferences in Fy/97.

NORMAL AGENCY MANAGEMENT

The Department of Fish and Game is not ordinarily fiscally prepared to respond to events outside it control. However, we feel that the department must respond to events (such as the *Exxon Valdez* Oil Spill) that could threaten the health and existence of wild fish stocks such as the wild stock Sockeye Salmon of Delight and Desire Lakes. However, to adequately assess the current status of the salmon stocks at Delight and Desire and determine methods to rehabilitate those stocks, fiscal assistance is required from other sources. In Lower Cook Inlet, the Division of Commercial Fisheries (Development Section) has an excellent track record with respect to enhancing and rehabilitating sockeye salmon stocks. However, the projects were possible only with funding assistance from other sources such as the Cook Inlet Aquaculture Association, Bureau of Indian Affairs, Cook Inlet Seiners Association and economic grants from the City of Homer.

Any additional injury to the salmon stocks at Delight and Desire Lakes, directly related to the oil spill may not be evident, however, services lost to the commercial and sport fishery could persist if the salmon stocks continue to remain below the escapement levels set by ADF&G.

Recovery of the sockeye stocks at Delight and Desire Lakes would support the efforts already made by the *Exxon Valdez* Trustee Council to restore services and injuries to sockeye salmon throughout the range of the spill area.

The increased numbers of salmon in the East Nuka Subdistrict would facilitate management efforts for a sustained maximum yield as well as providing for increased harvests for both the sport and commercial fishery.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

As previously mentioned, the Development Section of ADF&G has been and is currently involved in cooperative projects similar to the proposed project. Research and historical data are available from these projects for use with the proposed project.

The Department of Fish and Game currently operates a lake fertilization program on Leisure Lake in cooperation with the Cook Inlet Aquaculture Association and the Cook Inlet Seiners Association. ADF&G has several pieces of sampling and field equipment (field camps, limnology survey equipment etc.) that can be used with the Delight and Desire Lakes project.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

Phase two of this project will actually apply fertilizer to one or both lakes. A proposed long term funding source has been proposed. It would include possibly increasing the revenue goal for one or more of the currently operating special harvest areas located in Lower Cook Inlet set up and operated by the Cook Inlet Aquaculture Association (Figure 5&6).

PROPOSED PRINCIPAL INVESTIGATOR

Nick Dudiak
Alaska Department of Fish and Game
3298 Douglas Street
Homer, Alaska 99630
907-235-8191
907-235-2448
NickD@fishgame.state.ak.us

PERSONNEL

Lower Cook Inlet Fisheries Development Association, Proposer:

Ken Castner.....Interim President

Darlene Hilderbrand.....Executive Secretary

Board Members

John Wise	Roy Cabana
Rob Nelson	Chris Moss
Ken Castner	Joe Brunner
Jessie Nelson	Glen Carroll
Glen Carroll	Drew Scalzi

Alaska Department of Fish and Game (Lead Agency)

Project leader: Nick C. Dudiak; Lower Cook Inlet Fisheries Resource Development Biologist.

Mr. Dudiak has been a fisheries biologist with the Alaska Department of Fish and Game for the last 19 years. He has been responsible for the commercial and sport fisheries rehabilitation and enhancement work in the Lower Cook Inlet area during those 18 years. In this capacity, he has been responsible for multi-disciplinary work involving the rehabilitation of depleted salmon stocks as well as enhancement activities that have created new and developing commercial and sport fisheries.

Project Manager: Mark Dickson, Fish and Wildlife Technician IV.

Mr. Dickson has been employed as a fish culturist and fish and game technician with the Alaska Department of Fish and Game for the past 19 seasons. He has considerable experience in fish cultural practices in the field and in the hatchery managing projects that restores and enhances sport and commercial fisheries in the Lower Cook Inlet area.

Gary Kyle, Regional Limnologist, Limnology Laboratory, Alaska Department of Fish and Game, Division of Commercial Fisheries, Management and Development, Soldotna.

Mr. Kyle has been employed with ADF&G since 1977. Since 1988, Mr. Kyle has served as the regional limnologist for the Southcentral Region comprising of the Interior, PWS, Cook Inlet and Alaska Peninsula. Mr. Kyle has presented 34 technical reports, 8 journal manuscripts, 24 formal

presentations and 6 magazine articles dealing with adult sockeye production, lake fertilization, lake stocking, and in-lake assessments of juvenile sockeye production.

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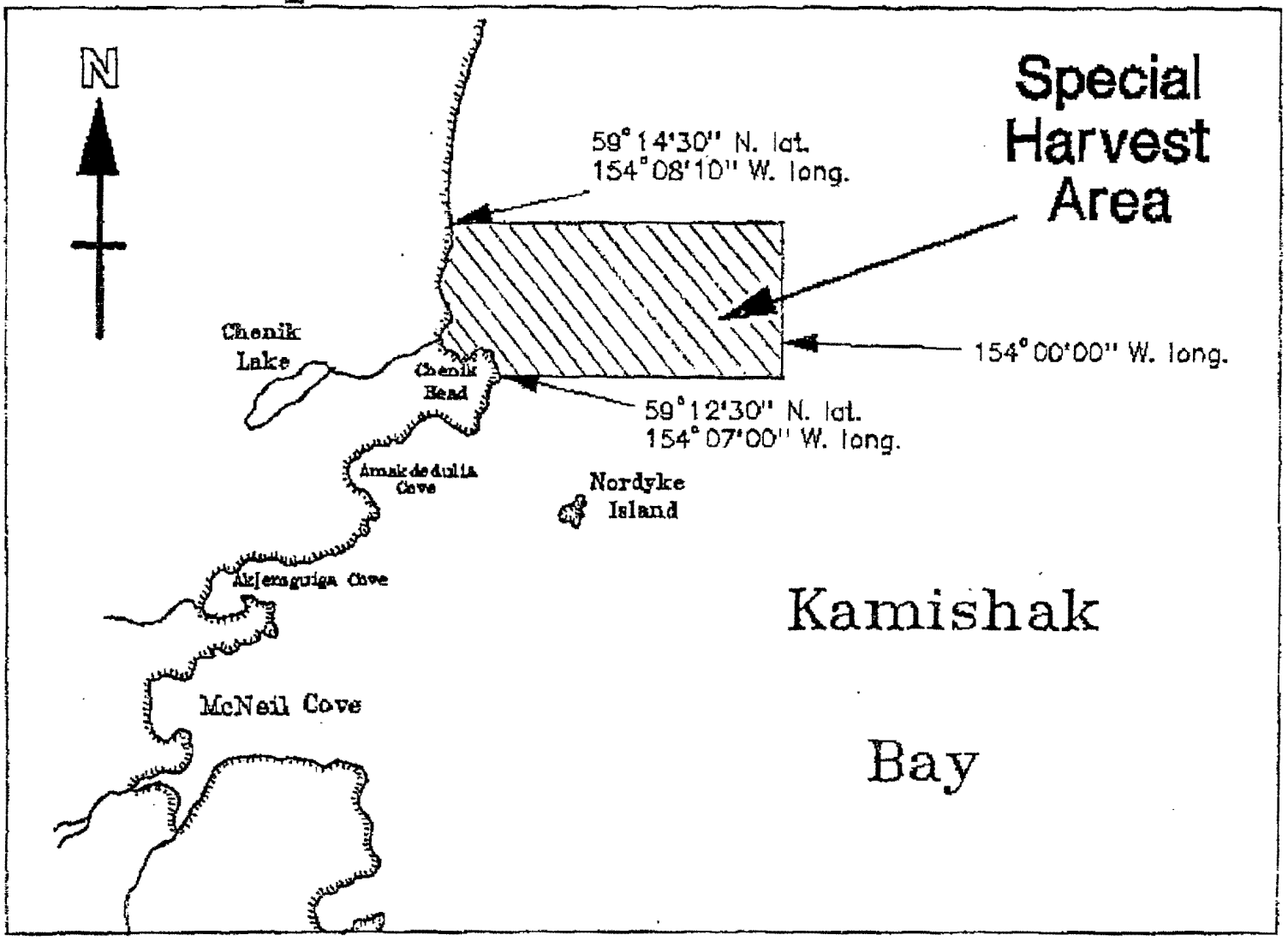
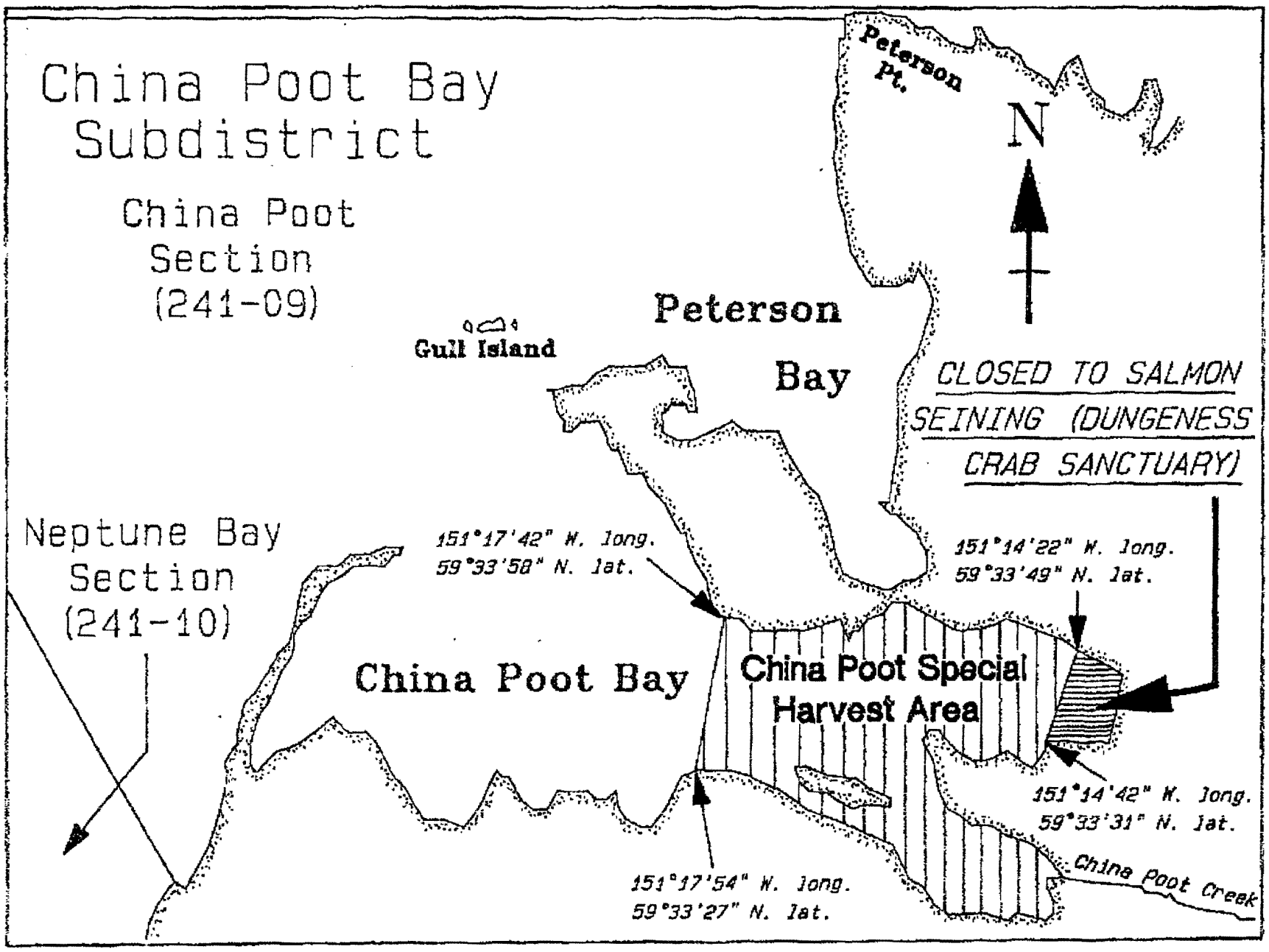
FIGURES

CHENIK
Special Harvest Area




China Poot Bay
Subdistrict
China Poot
Section
(241-09)
Peterson
Pt.
N
Gull Island
Peterson
Bay
CLOSED TO SALMON
SEINING (DUNGENESS
CRAB SANCTUARY)
Neptune Bay
Section
(241-10)
151°17'42" W. long.
59°33'58" N. lat.
151°14'22" W. long.
59°33'49" N. lat.
China Poot Bay
China Poot Special
Harvest Area
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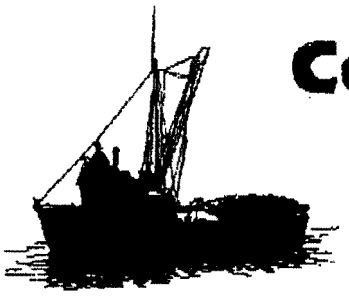
59°33'31" N. lat.
China Poot Creek
151°17'54" W. long.
59°33'27" N. lat.

APPENDIX



Cook Inlet Seiners Association
P.O. Box 4311
Homer, Alaska 99603
235-2656

April 6, 1996

Ms. Molly NcCammon, Executive Director
Exxon Valdez Trustee Council
645 "G" Street, Suite 401
Anchorage, Alaska 99501-3451

Re: Delight and Desire Lakes Enrichment and Sockeye Salmon Enhancement Project

Dear Ms. McCammon:

As you may recall, last year the Lower Cook Inlet Seiners Association (CISA) submitted a proposal to the *Exxon Valdez* Trustee Council for fertilization of Delight and Desire Lakes. It was withdrawn because timing did not allow the development of a full-blown, technical proposal.

After discussions with CISA, LCI Fisheries Corporation (LCIFDC) decided to submit the Delight and Desire Lakes Enrichment and Sockeye Salmon Enhancement Project to the *Exxon Valdez* Trustee Council for funding this year. The Port Graham Native Association, which recently received title to the land around Delight and Desire Lakes, as well as CISA, fully support the LCIFDC proposal. Alaska Department of Fish and Game (ADFG), Homer area office, is also actively supportive and have provided technical expertise in preparing the proposal.

Little has been done to restore affected fish stocks in the outer coast of the Kenai Peninsula, LCI, even though this area was heavily oiled and damaged by the *Exxon Valdez* oil spill. Since the spill in 1989, run failures have occurred across almost all species of salmon and throughout most of LCI. Prior to 1989, the LCI supported healthy salmon fisheries that economically benefitted the entire region as well as the state. Restoration of these affected stocks must be accomplished as soon as possible to preserve unique runs and the fishermen that harvest them. Funding for the Port Dick Spawning Channel Project is a good starting point and, yet it is just a beginning. Much still needs to be done to restore LCI salmon runs to pre-spill health.

CISA appreciates the enormity of the restoration efforts throughout the range of the oil spill including the outer coast of the Kenai Peninsula. In that spirit, CISA encourages you and the Trustee Council to give this proposal your utmost attention and consideration.

If you have any questions, do not hesitate to contract us. We are more than willing to discuss this proposal with you.

Sincerely,

Chuck Walkden, President
Cook Inlet Seiners Association

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997						
Personnel		$80.2						
Travel		$0.9						
Contractual		$22.0						
Commodities		$10.8						
Equipment		$1.8	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$115.7	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
General Administration		$13.6						
Project Total	$0.0	$129.3	$96.1					
Full-time Equivalents (FTE)		2.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

OTHER RESOURCES: As outlined in the Detailed Project Description, mechanisms to derive revenue from cost recovery efforts in special harvest areas are being explored. These funds may be available to cover the cost of fertilization after the second year of the project.

LONG RANGE FUNDING REQUIREMENTS: It is difficult to estimate the funding requirements beyond FY/98. Funding levels will depend on the amount and type of fertilizer used and other resources such as cost recovery efforts. These variables will be determined during phase one (pre-fertilization) of the project.

REPORT WRITING: 1.5 months of the proposed personnel costs will be allotted to the Fisheries Technician IV for report writing.

(Received/ edited: 11 Apr 96; WJH)

1997

Prepared: 4/96

Project Number: 97254
Project Title: Delight and Desire Lakes Restoration Project
Agency: Alaska Dept of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/12/96

1997 EXXON VALDEZ TRUST_ COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1997
Limnology, management						
11-5243	Fish and Game Technician IV	13E	4.0	4075.0		16.3
11-5338	Fish and Game Technician III	11A	3.0	3225.0		9.7
Delight Lake PCN unknown						0.0
Field camp personnel:	Fish and Game Technician III	11A	4.5	3225.0		14.5
Smolt eval. & adult enumeration	Fish and Game Technician II	9A	4.5	2800.0		12.6
						0.0
Desire Lake PCN unknown						0.0
Field camp personnel:	Fish and Game Technician III	11A	4.5	3225.0		14.5
Smolt eval. & adult enumeration	Fish and Game Technician II	9A	4.5	2800.0		12.6
						0.0
						0.0
	Subtotal		25.0	19350.0	0.0	
					Personnel Total	$80.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
Round trip, Homer to Anchorage and return	180.0	1	1	150.0	0.3
Round trip, Homer to Anchorage overnight and return	180.0	1	2	150.0	0.5
Round trip, Homer to Port Graham and return	100.0	1	1	0.0	0.1
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.9

1997

Prepared: 4/96

Project Number: 97254
Project Title: Delight and Desire Lakes Restoration Project
Agency: Alaska Dept of Fish and Game

FORM 3B
Personnel
& Travel
DETAIL

4/12/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Contractual Costs:	Proposed FFY 1997
Description	
Delight Lake	
2 trips float plane to transport camp in and out at $530.00/hr at 2hrs per trip	2.1
5 trips float plane to supply camp and to complete required limnology surveys at $165.00/hr x 2 hrs per trip	1.7
4 hrs aircraft standby time to sample lakes @ $83.00/hr	0.3
1 trip helicopter to sling boat to one lake @ $600.00/hr at 2 hrs. per trip	1.2
Limnological analysis @ $315.00 per station per depth per date: ($315.00x 1 lake 2 stations x 2 depths per station x 5 sample dates)	6.3
Desire Lake	
2 trips float plane to transport camp in and out at $530.00/hr at 2hrs per trip	2.1
5 trips float plane to supply camp and to complete required limnology surveys at $165.00/hr x 2 hrs per trip	1.7
4 hrs aircraft standby time to sample lakes @ $83.00/hr	0.3
Limnological analysis @ $315.00 per station per depth per date: ($315.00x 1 lake 2 stations x 2 depths per station x 5 sample dates)	6.3
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$22.0

Commodities Costs:	Proposed FFY 1997
Description	
Delight and Desire Lakes	
New fyke net and materials to construct holding boxes for emigrating fry	2.0
Camp supplies: Cookware, water filters, table & chairs etc. (2 camps)	0.7
Oil fired heating stove (2 camps)	0.4
200 gals. stove oil @ $1.25 per gallon	0.3
Smolt sampling gear: Weighing scales, microscope slides, buckets, data sheets & supporting office & lab supplies	0.2
Clothing: Wading boots, raingear (jackets & pants) 4 people	0.7
Food: 2 camps, 4 people @ 75 days per camp (4x75 days @ $15.00/day/person)	4.5
Materials to construct 2 adult weirs	2.0
Commodities Total	$10.8

1997

Prepared: 4/96

Project Number: 97254
Project Title: Delight and Desire Lakes Restoration Project
Agency: Alaska Dept of Fish and Game

FORM 3B
Contractual & Commodities DETAIL

4/12/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
Delight Lake			0.0
1 generator to recharge batteries (used for communications)	1	800.0	0.8
1 marine cycle battery	1	75.0	0.1
			0.0
Desire Lake			0.0
1 generator to recharge batteries	1	800.0	0.8
1 marine cycle battery	1	75.0	0.1
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$1.8

Existing Equipment Usage: Description	Number of Units	Inventory Agency
High frequency (single side band) radios	2	ADF&G
10x12' wall tent	1	ADF&G
12x15' weatherport, (previously purchased by the Trustee Council)	1	ADF&G
Aluminum boat to conduct limnology studies	1	ADF&G
Inflatable boat to conduct limnology studies	1	ADF&G
Smolt sampling gear; weighing scale, microscope slides, buckets	1	ADF&G
Adult beach seines	2	ADF&G
15 HP outboard motor	1	ADF&G
25HP outboard motor	1	ADF&G
Boating equipment; gas tanks, oars, tool kits	2	ADF&G
First aid and survival kits	2	ADF&G
Firearms	2	ADF&G
Laboratory equipment & instruments: microscopes, microfiche readers (to read fish scales)	1	ADF&G

1997

Project Number: 97254
Project Title: Delight and Desire Lakes Restoration Project
Agency: Alaska Dept of Fish and Game

FORM 3B
Equipment
DETAIL

Prepared: 4/96

4/12/96

Kenai River Sockeye Salmon Restoration

Project Number:	97255
Restoration Category:	General Restoration
Proposer:	ADF&G
Lead Trustee Agency:	ADF&G
Cooperating Agency:	None
Alaska SeaLife Center:	
Duration:	6th year, 6-year project
Cost FY 97:	$193,300
Cost FY 98:	$0
Cost FY 99:	$0
Cost FY 00:	$0
Cost FY 01:	$0
Geographic Area:	Upper Cook Inlet
Injured Resource/Service:	Sockeye Salmon

ABSTRACT

Sockeye salmon (*Oncorhynchus nerka*) that spawn in the Kenai River system were injured by the *Exxon Valdez* Oil Spill. Due to the presence of oil in the Upper Cook Inlet, fishing was reduced, and sockeye salmon escapement to the Kenai River greatly exceeded target levels. The overescapement resulted in reduced survival of juvenile sockeye salmon. Careful monitoring of Kenai River sockeye salmon harvests may be necessary to restore the productivity of the system. Genetic data were collected from all significant spawning populations contributing to mixed-stock harvests in Cook Inlet. Both allozyme and mtDNA reveal a substantial amount of genetic diversity among populations and suggest that significant local adaptation has occurred. Mixed-stock analyses were used to estimate the proportion of Kenai River populations in Central District driftnet and setnet fisheries. Results from this study are currently being used in the management and restoration of Kenai River sockeye salmon injured in the 1989 *Exxon Valdez* oil spill. FY97 is the final year for this project.

INTRODUCTION

Fishing time in the Upper Cook Inlet was greatly reduced in 1989 due to the presence of oil from the *Exxon Valdez* Oil Spill, and as a direct result, sockeye salmon (*Oncorhynchus nerka*) spawning in the Kenai River system greatly exceeded optimal escapement goals. The biological impact of the spill may be one of the most serious documented to date.

Restoration of these injured Kenai River sockeye salmon can best be accomplished through improved stock assessment capabilities, more accurate regulation of spawning levels, and modifications to human use. Sockeye salmon harvested from the mixed-stock fishery of Cook Inlet include fish from the Kenai, Kasilof, and Susitna Rivers. In order to effectively manage the harvest of EVOS-damaged stocks, Restoration Science Studies R59/93012/94255 were implemented in 1992, 1993, and 1994. These studies developed a Genetic Stock Identification (GSI - allozyme electrophoresis) baseline to identify Kenai River stocks in mixed-stock Cook Inlet fisheries. The statistical methods associated with the fishery estimates were refined, and the accuracy and precision of the estimates were evaluated. Projects 95255 and 96255 continued these projects through FY95 and FY96, adding populations to the baseline and providing stock contribution estimates for fishery managers. Area managers can now use this information to modify fishing areas and openings in order to improve management of Kenai River and other Upper Cook Inlet stocks.

NEED FOR THE PROJECT

A. Statement of Problem

Data collected by NRDA Fish/Shellfish Study 27, *Sockeye Salmon Overescapement*, indicated greatly reduced survival of juvenile sockeye salmon beginning with the 1989 parent year. The extremely high escapement may have initially produced more rearing juvenile sockeye salmon than could be supported by nursery lake productivity. In general, when rearing salmon abundance greatly exceeds lake carrying capacity, the species and size composition of prey resources are altered, affecting all trophic levels. Because of such changes, juvenile growth is reduced, freshwater mortality is increased, greater proportions of fry remain in the lake for an additional year of rearing, smolt condition is reduced, and marine mortality is increased.

Limiting sockeye salmon fry production by closely regulating the number of spawning adults may be the only way to restore the productivity of these rearing areas.

B. Rationale/Link to Restoration

Results from previous years' studies indicate that Cook Inlet sockeye salmon are extremely heterogeneous within the Kenai River and throughout Cook Inlet. Results indicated that this genetic heterogeneity can be used as an accurate stock identification tool. Extensive analyses of known mixtures indicated that Kenai River populations can be identified with a high degree of

accuracy and precision in mixtures typically found in Cook Inlet drift and set net fisheries. With information on stock contribution to the mixed-stock fishery in Cook Inlet, area managers can modify fishing areas and openings in order to manage the fishery while protecting the EVOS-injured Kenai River stocks.

A pilot study of fishery sampling was conducted during 1993, prior to the return of the first EVOS-affected stocks anticipated in 1994 (age-5 sockeye salmon from the 1989 parent year). Two fishery samplings were analyzed using the genetic baseline collected during the 1992 field season. The emphasis shifted during 1994, and four in-river collections were analyzed from the Kenai River as a test of the method. Two of these collections were analyzed in-season. In addition, one drift net fishery sample was analyzed post-season in 1994. In 1995, the Central District drift fishery was sampled on five occasions, the Eastside setnet fishery was sampled twice, and four inriver samples were taken from the Kenai River. Completion of the laboratory and statistical analyses within 48 hours was demonstrated in 1993, 1994, and 1995. Beginning in 1995, the GSI estimates were incorporated into fishery management decisions for in-season and post-season evaluations. In 1996, five samples will be taken from the Central District drift gillnet fishery during regular fishery periods. Up to two of these samples will be analyzed within 48 hours for use in making inseason management decisions.

C. Location

This project will take place in Upper Cook Inlet and will potentially benefit communities involved with salmon fisheries in Cook Inlet including the Susitna, Kenai and Kasilof River drainages.

COMMUNITY INVOLVEMENT

Reports have been presented to the Alaska Board of Fisheries, the Upper Cook Inlet Regional Planning Team, various fisherman's organizations and civic organizations in addition to the Trustee Council Public Advisory Group process. Residents of the Kenai Peninsula Borough are an important part of the Trustee Council-funded Kenai River restoration projects. Besides working on the projects in direct employment as ADF&G Fish and Wildlife biologists and technicians, the people of the Peninsula are kept well informed about these projects. Major media outlets in Anchorage and Kenai cover the issues affecting the Kenai River, including the Trustee Council-funded projects. In addition, local ADF&G project biologists have made presentations on restoration efforts to local governments, in local schools, and to community groups. Further, detailed discussions and program suggestions have resulted from the involvement of the Upper Cook Inlet Regional Planning Team. This team is composed of members from the Cook Inlet Regional Aquaculture Association and ADF&G. The team has held numerous meetings with diverse public participation to discuss the results to date of the Kenai River projects related to the spill.

PROJECT DESIGN

A. Objectives

The goal of this project is to restore Kenai River sockeye salmon injured by the oil spill. This will be accomplished through more accurate regulation of spawning levels using improved stock assessment capabilities. The specific objectives are to:

1. Obtain baseline genetic data (allozyme) from all significant spawning stocks contributing to mixed-stock harvests of sockeye salmon in Cook Inlet.

2. Use Genetic Stock Identification algorithms to estimate the proportion of Kenai River stocks in mixed stock fisheries so that managers may modify area and time of harvest. Stock composition estimates will be provided within 48 hours post-fishery.

3. Investigate the added utility of DNA-level markers to discriminate among Cook Inlet populations.

4. Provide more accurate estimates of abundance of Kenai River sockeye salmon within Cook Inlet through hydroacoustic assessment techniques.

5. Prepare and complete the analysis and archiving of all data and tissue samples obtained during the course of the project.

Objectives 1, 3 and 4 will be completed by the end of FY96. Close out tasks (equipment storage and inventory, long term data storage, final report preparation etc.) will be conducted in FY97 for these objectives. The majority of effort in FY97 will focus on Objectives 2 and 5. In particular, we will complete the analysis of the 1996 samples, prepare abundance estimates, and complete data and tissue sample analysis and archiving.

B. Methods

Methods for the collection and analysis of genetic baseline and fishery sample data are fully explained in the final report for Restoration Projects 93012 and 94255. In FY97, any new data or analyses will follow procedures previously reported.

Estimates of abundance of sockeye salmon within Upper Cook Inlet, using hydroacoustic equipment, will be performed as needed for management by ADF&G personnel at no cost to the EVOS Trustee Council. Use of hydroacoustic equipment, purchased during this project, is required to continue this effort.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

None

SCHEDULE

A. Measurable Project Tasks for FY97

October 1996 - January 1997:	Complete laboratory analyses of allozyme and DNA samples from 1996
November 1996 - April 1997:	Statistical analyses of mixtures; refinement of technique; archiving of tissues and data
January 22 - 25, 1997:	Attend Annual Restoration Workshop
February - April 1997:	Draft final report for FY96
April - September 1997:	Revise final report for FY96; prepare manuscripts for publication

B. Project Milestones and Endpoints

August 1995:	Objective 1 completed
January 1997:	Objective 2 completed. Any further work will be funded by the state.
January 1997:	Objective 3 completed
December 1996:	Objective 4 completed. Any further work will be funded by the state.
September 1997:	Objective 5 completed

C. Completion Date

September 31, 1997

PUBLICATIONS AND REPORTS

1. Genetic diversity of sockeye salmon populations (*Oncorhynchus nerka*) from areas affected by the *Exxon Valdez* Oil Spill. Canadian Journal of Fisheries and Aquatic Sciences. To be submitted May 1996. Revisions expected FY97.

2. Genetic variation in Alaska sockeye salmon injured by the *Exxon Valdez* Oil Spill as revealed by mitochondrial DNA (mtDNA). Transactions of the American Fisheries Society. To be submitted June 1996. Revisions expected FY97.

3. Concordance of genetic divergence among sockeye salmon populations for allozyme, nuclear DNA, and mtDNA markers. Molecular Ecology. To be submitted May 1996. Revisions expected FY97.

4. Microsatellite markers reveal high heterogeneity among sockeye salmon populations affected by the *Exxon Valdez* Oil Spill. Canadian Journal of Fisheries and Aquatic Sciences. To be submitted Fall-Winter FY97.

PROFESSIONAL CONFERENCES

Study results will be presented at the Annual meeting of the American Fisheries Society, August 1997, Monterey, California.

NORMAL AGENCY MANAGEMENT

Project is being closed-out. Project will be continued as a portion of the normal agency management responsibility pending available funding.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The investigations of Kenai River sockeye salmon have been integrated with long term research efforts by the Alaska Department of Fish and Game. These efforts include adult salmon enumeration by hydroacoustic techniques in various river systems, catch and escapement sampling of salmon for age, length, and weight, test fishing at the Central District southern boundary, and juvenile salmon rearing studies. Development of restoration strategies on the Kenai Peninsula through a review process with the Regional Planning Team and with ADF&G review teams composed of personnel from all ADF&G divisions.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

None

PROPOSED PRINCIPAL INVESTIGATOR

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PERSONNEL

Lisa W. Seeb (L. Wishard), Statewide Geneticist
Division of Commercial Fisheries Management and Development
Alaska Dept. of Fish and Game
Anchorage, Alaska 99518 (907) 267-2249

EDUCATION:

A.B. Zoology, 1973, University of California, Berkeley
M.A. Zoology, 1977, University of Montana
Ph.D. Fisheries, 1986, University of Washington

PROFESSIONAL EXPERIENCE:

1991-	Statewide Geneticist, ADF&G, Anchorage
1991-	Affiliate Associate Professor, University of Alaska Fairbanks
1988-1990	Assistant Professor, Southern Illinois University
1984-1988	Research Assist. Prof., University of Idaho
1978-1981	Fish Geneticist, Pacific Fish. Research, Olympia WA
1977-1979	Geneticist, National Marine Fisheries Service, Seattle

SELECTED PUBLICATIONS:

Wishard, L. N., J. E. Seeb, F. M. Utter, and D. Stefan. 1984. A genetic investigation of suspected redband trout populations. Copeia 1984(1):120-132.

Seeb, J. E., L. W. Seeb, and F. M. Utter, 1986. Use of genetic marks to assess stock dynamics and management programs for chum salmon. Trans. Amer. Fish. Soc. 115:448-454

Seeb, L. W. and D. R. Gunderson. 1988. Genetic variation and population structure of Pacific ocean perch (Sebastes alutus). Can. J. Fish. Aquat. Sci. 45:78-88.

Seeb, L. W., J. E. Seeb, R. L. Allen and W. K. Hershberger. 1990. Evaluation of adult returns of genetically marked chum salmon, with suggested future applications. American Fisheries Society Symposium 7:418-425

Seeb, L. W., J. E. Seeb and A. J. Gharrett. 1990. Genetic marking of fish populations. pp 223-239 *in* D. H. Whitmore, ed. Electrophoretic and isoelectric focusing techniques in fisheries management. CRC Press, Boca Raton, FL.

Seeb, L. W., J. E. Seeb and J. J. Polovina. 1990. Genetic variation in highly exploited spiny lobster *Panulirus marginatus* populations from the Hawaiian Archipelago. Fishery Bulletin 88:713-718.

Seeb, L. W. and A. W. Kendall. 1991. Allozyme polymorphisms permit the identification of larval and juvenile rockfishes of the genus *Sebastes*. Environmental Biology of Fishes 30:191-201.

Utter, F. M., J. E. Seeb, and L. W. Seeb. 1993. Complementary uses of ecological and biochemical genetic data in identifying and conserving salmon populations. Fisheries Research. Fish. Res. 18:59-76.

Crane, P. A., L. W. Seeb, and J. E. Seeb. 1994. Genetic relationships among *Salvelinus* species inferred from allozyme data. Can. J. Fish. Aquat. Sci. 51(Suppl. 1):182-197.

Kenneth E. Tarbox
Alaska Department of Fish and Game
34828 Kalifornsky Beach Road, Suite B
Soldotna, Alaska 99669 (907) 260-2911

EMPLOYMENT:

May, 1980 to Present. Upper Cook Inlet Research Project Leader, Alaska Department of Fish and Game, Soldotna, Alaska. Responsibilities include planning, implementing, supervision, and reporting on various salmon related research and management projects. These involve hydroacoustic enumeration of salmon in glacial systems, defining salmon migratory behavior in both salt and fresh water, evaluation of potential impacts of resource development on habitat and populations, management of the UCI commercial salmon fisheries, stock identification studies using scale or genetic markers, and life history studies of sockeye salmon.

March, 1972 to May, 1980. Project manager and Senior Biologist, Woodward Clyde Consultants, Anchorage, Alaska. Responsibilities included supervision and research for a number of projects. These included an evaluation of existing methodologies for determining instream flow requirements for Alaskan fishes, determining the biological impact of a dredging projects located in lower New York Harbor and Lake Michigan, fishery investigations in the Zayandeh River, Iran, impact assessment of various oil related projects in Virginia, North Carolina, Texas, and Prudhoe Bay, Alaska, and studies and evaluation of impacts associated with nuclear power plants in New Jersey, Louisiana, Indiana, and Pennsylvania.

July, 1970 to March, 1972. Research Assistant, Louisiana Co-operative Fishery Unit, Louisiana State University, Baton Rouge, La. Responsibilities included the design and conduct of a one year investigation of juvenile fish behavior in an estuarine environment.

EDUCATION:

M.S. in Fisheries, 1974. Louisiana State University, Baton Rouge, La.
B.S. in Fisheries Science. 1970. University of Washington, Seattle, Wa.

CERTIFICATIONS:

Fisheries Scientist, Certificate 1165, American Fisheries Society, 1976.

PUBLICATIONS:

Available on request

James E. Seeb, Principal Geneticist
Commercial Fisheries Management and Development
Alaska Department of Fish and Game
Anchorage, Alaska 99518 (907) 267-2385

EDUCATION: B.S., Biology, 1974, University of Puget Sound
M.S., Fisheries, 1982, University of Washington
Ph.D., Fisheries, 1987, University of Washington

PROFESSIONAL EXPERIENCE:

1990- Principal Geneticist, CFMD Division, ADF&G
1991- Affiliate Associate Professor, University of Alaska Fairbanks
1988-1990 Assistant Professor, Southern Illinois University
1987-1988 Research Assistant Professor, University of Idaho
1982-1986 Graduate Research Assistant, University of Washington
1980-1982 Fish Biologist, Pacific Fisheries Research, Olympia,WA
1978-1980 Fish Biologist, Washington Department of Fisheries

SELECTED PUBLICATIONS:

Seeb, J.E., L.W. Seeb, and F.M. Utter. 1986. Use of genetic marks to assess stock dynamics and management programs for chum salmon. Trans. Amer. Fish. Soc. 115:448-454.

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Seeb, J.E., and G.D. Miller. 1990. The integration of allozyme analyses and genomic manipulations for fish culture and management. *In*: D.H. Whitmore, Editor. Electrophoretic and Isoelectric Focusing Techniques in Fisheries Management. CRC Press, Boca Raton, pp 266-279.

Gharrett, A. J. B. Riddell, J. Seeb, and J. Helle. 1993. Status of the Genetic Resources of Pacific

Rim Salmon. In: J. Cloud, Editor. Genetic Conservation of Salmonid Fishes. Plenum Press, New York. pp. 286-292.

Utter, F. M., J. E. Seeb, and L. W. Seeb. 1993. Complementary uses of ecological and biochemical genetic data in identifying and conserving salmon populations. Fisheries Research. Fish. Res. 18:59-76.

Crane, P. A., L. W. Seeb, and J. E. Seeb. 1994. Genetic relationships among *Salvelinus* species inferred from allozyme data. Can. J. Fish. Aquat. Sci. 51(Suppl. 1):182-197.

LITERATURE CITED

None

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Personnel	$214.8	$125.2						
Travel	$6.6	$8.6						
Contractual	$28.0	$17.5						
Commodities	$23.4	$22.0						
Equipment	$0.0	$0.0						
Subtotal	$272.8	$173.3						
General Administration	$34.2	$20.0						
Project Total	$307.0	$193.3	$0.0					
Full-time Equivalents (FTE)		2.7						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1997

Prepared:

Project Number: 97255
Project Title: Kenai River Sockeye Salmon Restoration
Agency: ADF&G

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1997
Davis	FB 1 PCN 1333	14J	6.0	4,726		28.4
Seagren	AC 111 PCN 1323	10K	3.0	3,628		10.9
Vacant	FB1	14B	1.0	3,828		3.8
	FWT III	11C	14.0	3,355		47.0
W. Templin	FB II	16B	8.0	4,390		35.1
	Subtotal		32.0	19927.0	0.0	
					Personnel Total	$125.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
5 Rt Anchorage to Kenai	130	5			0.7
Per Diem			10	125	1.3
2 Round trips Anchorage to Juneau	444	2			0.9
7 Round trips Anchorage to Kenai	130	7			0.9
3 Round trips Scientific meeting	600	3			1.8
20 days per diem at 150/day			20	150	3.0
				Travel Total	$8.6

1997

Prepared:

Project Number: 97255
Project Title: Kenai River Sockeye Salmon Restoration
Agency: ADF&G

FORM 3B
Personnel
& Travel
DETAIL

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Contractual Costs:	Proposed
Description	FFY 1997
Repair of equipment, storage of gear, and miscellaneous	3.0
Laboratory maintenance	3.0
Phone	1.5
Equipment maintenance	5.0
Photography and publication	5.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$17.5

Commodities Costs:	Proposed
Description	FFY 1997
Biochemicals	17.0
Miscellaneous laboratory supplies	2.0
DNA biochemicals	2.0
Office supplies	1.0
Commodities Total	$22.0

1997

Prepared:

Project Number: 97255
Project Title: Kenai River Sockeye Salmon Restoration
Agency: ADF&G

FORM 3B
Contractual & Commodities DETAIL

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1997

Project Number: 97255
Project Title: Kenai River Sockeye Salmon Restoration
Agency: ADF&G

FORM 3B
Equipment
DETAIL

Prepared:

4/15/96

Sockeye Salmon Stocking at Columbia Lake.

Project number:	97256a
Restoration Category:	General Restoration
Proposer:	USFS
Lead Trustee Agency:	USFS
Cooperating Agencies:	ADF&G
Duration:	2nd year, 7-year project
Cost FY 1997:	$34,400
Cost FY 1998:	TBD
Cost FY 1999:	TBD
Cost FY 2000:	TBD
Cost FY 2001:	TBD
Cost FY 2002:	TBD
Geographic Area:	Prince William Sound
Injured Resource:	Subsistence/Sockeye Salmon

ABSTRACT

This project is designed specifically to benefit subsistence users of northern PWS by stocking sockeye salmon in Columbia Lake. The lake is a predominantly clearwater lake that has recently become accessible to anadromous fish as Columbia Glacier has retreated. There are two phases to this project: the feasibility phase of this project (FY96 and FY97) will determine the ability of Columbia Lake to support a resident population of sockeye salmon. Phase 2 of the project would be to stock the lake with sockeye salmon. If the project is found to be feasible, stocking of the lake could begin in 1999. The stocking program would take five years to establish a self-sustaining run.

INTRODUCTION

Subsistence resources and services were injured throughout Prince William Sound as a result of the *Exxon Valdez* Oil Spill. This project proposal continues an investigation of the potential to improve subsistence opportunities through the stocking of sockeye salmon (*Oncorhynchus nerka*) in Columbia Lake, Heather Bay, in Prince William Sound (PWS). This lake is adjacent to Columbia Glacier and has recently become accessible to anadromous fish as the glacier has receded. Columbia Lake provides an excellent opportunity to establish a replacement fishery to benefit subsistence users in Prince William Sound. Establishing a resident sockeye salmon population in this lake would also provide additional benefits to sport fisheries.

This project began in 1996 and the feasibility phase of the project will continue through FY97. In 1996 the Trustee Council funded project 96256 which was a combined proposal to assess the feasibility of stocking programs at Columbia Lake and at Solf Lake on Knight Island. These proposals have been split into 97256a (Columbia Lake) and 97256b (Solf Lake) because the anticipated work needed in 1997 differs substantially between the two locations. Preliminary results and recommendations from the Columbia Lake feasibility project will be available in December 1996 for the Trustee Council to determine if stocking could begin in 1999. Because no limnological data were available for Columbia Lake prior to 1996, this proposal includes a second year of data collection which is required under ADF&G's management plan (G.Kyle, personal communication 1996). An updated detailed project proposal will be provided once the results from the 1996 season have been analyzed.

Columbia Lake has been recognized for its potential for enhancement of salmon fisheries for subsistence and sport uses. The lake was included in the Prince William Sound - Copper River Comprehensive Salmon Plan - phase II (1986) where it is recommended for implementation if funds become available. In April 1995 this project, along with a stocking proposal for a program at Solf Lake on Knight Island, was presented to the Prince William Sound/Copper River Regional Fisheries Planning Team for consideration and approval. They recommended that an RPT checklist be completed and that the project be coordinated with Alaska Department of Fish and Game (ADF&G) and Prince William Sound Aquaculture Corporation (PWSAC) to obtain required permits and hatchery space. These tasks are to be completed in 1996.

In 1996 limnological data will be collected from Columbia lake. These data include algal biomass, zooplankton biomass, temperature and bathymetric profiles, dissolved oxygen, and water chemistry, as well as an inventory of resident fish populations. Analysis of these samples began in August of 1996 and are expected to be completed by November 1996. The results of the analyses from FY96 and FY97 will be used to determine if the lake is capable of sustaining a sockeye salmon population.

NEED FOR THE PROJECT

A. Statement of Problem

Subsistence use of resources in the oil spill area declined following the spill. Although restoration studies have shown that harvest levels have since returned to prespill levels in most oil spill communities, Chenega Bay and Tatitlek are exceptions (Seitz and Fall, 1995; Seitz and Miraglia, 1995). These communities showed reduced harvest levels in 1993/94 and an increased reliance on salmon harvests (Seitz and Fall, 1995; Seitz and Miraglia, 1995). In addition, the *Exxon Valdez* Restoration Office's Invitation to submit proposals for FY97 stated that subsistence users are traveling greater distances and invest more time in subsistence harvesting than they did prior to the spill. Columbia Lake provides an opportunity to establish a large replacement fishery that is easily accessible for subsistence users from Tatitlek and northern Prince William Sound.

This project determines the feasibility of stocking Columbia Lake with sockeye salmon as a replacement fishery for subsistence use. Although no historical limnological data exists for Columbia Lake, there is reason to expect that the lake has developed the planktonic base needed to support a sockeye population. In the early 1970's plankton samples were collected from the lake by the USFS to assess its capability to support fish if a fishpass were installed. The fishpass project was not pursued when USGS predicted that the glacier would receed far enough to create access to the lake. Although the actual sampling records were not located, personal discussions with the lead biologist suggest that planktonic populations were well established in the lake (Holbrook, personal communication, 1995).

B. Rationale/Link to Restoration

Columbia Lake is located next to Columbia Glacier in Northern Prince William Sound. The lake is on land managed by the Chugach National Forest but has been overselected by Tatitlek for conveyance under ANCSA. The lake is approximately 2.8 km^2 in surface area and has the potential to support a population of sockeye salmon for subsistence use. The estimated total production is 10,500 to 28,700 fish/annually. This proposal is for the continuation of a project that establishes the feasibility of stocking Columbia Lake with sockeye salmon. Phase 2 of this project would be to stock Columbia Lake and monitor the introduced population and its effect on the lake. Should the results be favorable, the newly established population would be easily accessible to Tatitlek residents who already travel past Columbia Lake to Billy's Hole to harvest sockeye salmon for subsistence use. The successful establishment of a resident fish population in Columbia Lake would directly benefit subsistence users in Northern Prince William Sound by providing a replacement fishery that is easily accessible to residents in Tatitlek and Valdez.

Background: Until 1989, Columbia Lake was a meltwater basin of the Columbia Glacier with the water level maintained by a glacial dam on the west shore. The eastern portion of the lake was clear water, with an outlet stream located at the south end of the lake. A large fall was located on the outlet stream, and it is believed that the lake system was inaccessible to

anadromous fish until a new outlet was created as the glacier retreated. The glacier retreated from the lake in 1989, and the new lake outlet flows across a moraine on the west shore. Glacial meltwater enters the lake on the northwestern shore and exits the lake on the western shore leaving the remainder of the lake mostly clear water. The glacier has retreated behind a moraine northwest of Heather Island, and Heather Bay, the estuary of the Number One River, is now free of ice bergs.

C. Location

Columbia Lake is located near the southeast terminus of Columbia Glacier, in Heather Bay, PWS. It is the lowest of four lakes in the Number One River drainage. The lake is unnamed on USGS maps; however, Nickerson (1978) and PWSRPT (1983) refer to the lake as Columbia Lake (ADF&G stream 205). This lake is described in the Anadromous Waters Catalog (ADF&G, 1992) as number 222-10-12040-0010.

The lake is easily accessible from Valdez and Tatitlek; and may also benefit subsistence users from Chenega, Cordova and Whittier. This project may also provide incidental benefit to sport fishers in the area.

COMMUNITY INVOLVEMENT

This project is designed specifically to benefit subsistence users of northern PWS; therefore, community involvement is an important component for the success of the project. The feasibility phase of this project (FY96 and FY97) will determine the ability of Columbia Lake to support a resident population of sockeye salmon. Phase 2 of the project would be to stock the lake with sockeye salmon. Contacts with the Tatitlek community liaison will be maintained throughout the feasibility phase of this project to discuss the results of the limnological investigation and explain what the potential adult sockeye production might be. Assuming favorable results, and that the Trustee Council chooses to finance the stocking of the lake, additional community involvement could be incorporated into monitoring the success of the stocking program. Coordination with the Youth Area Watch Program (96210) was begun in 1996 to explore the possibilities of future involvement with this project.

PROJECT DESIGN

A. Objectives

Phase 1. The overall objective of this project is to determine the feasibility of stocking Columbia Lake with sockeye salmon. There are three components of this objective:

1. determine if Columbia Lake can sustain a resident population of sockeye salmon;
2. determine appropriate stocking levels that can be sustained by Columbia Lake;
3. coordinate with PWSAC and Main Bay hatchery to establish an appropriate brood stock and the necessary logistics to begin a stocking program.

Phase 2. This is the actual stocking stage of the project and is dependant upon the outcome of Phase 1. The objective of this phase of the project is to stock Columbia Lake with sockeye salmon to produce a self-sustaining population that can provide an adequate subsistence harvest.

B. Methods

Project 96256 included one season of data collection to determine presence of resident fish and the potential carrying capacity of Solf and Columbia Lakes. Because there are no historical data available for Columbia Lake, it is recommended that an additional year of limnological sampling occur to verify results. An additional year of sampling of resident fish populations may also be needed in 1997. The following section describes the sampling methodologies planned for use in FY97. Sampling methods scheduled for use in 1996 are attached to this proposal as Appendix A.

Limnological Sampling (1996 and 1997): Quantitative and qualitative data for zooplankton populations (biomass, body-sizes, species composition etc.), algal biomass (chlorophyll a), temperature and light profiles, dissolved oxygen and water quality would be collected to estimate the potential productivity of the lake. Procedures for the collection of these samples are detailed in Koenings et. al. (1987). Samples would be collected from a minimum of two permanent collection sites every three to four weeks during May through September to assess seasonal variation. Laboratory analysis of the samples will follow procedures in Koenings et al (1987) and ADF&G standards for water chemistry analysis. Most laboratory analyses will be processed in September and October after the last samples have been collected.

Fish Population Size (1997): If the initial trapping results yield high catches of resident fish, it would be important to estimate the population. The total number of fish in Columbia Lake will be estimated through a hydroacoustic survey. Age and size information will be obtained from the initial trapping and tow netting data. Species composition will be estimated from tow-net samples taken in conjunction with the hydroacoustic survey. Standard ADF&G procedures will be followed for the survey and analysis of results (Kyle, 1990).

Stocking Program (1998 to 2003): Appropriate stocking levels will be determined in coordination with ADF&G using the data collected in 1996 and 1997. If the decision is made to stock Columbia Lake, fry will be short-term reared at the Main Bay Hatchery and transported to the lake for release in June or July. 1999 is the earliest release date possible, the actual release time will be dependent upon space availability at Main Bay and/or ice cover and other conditions at the lake. Zooplankton will be sampled, using techniques described above, during each year of the stocking program to evaluate the affect of the stocking program on the plankton population.

Monitoring (1999 and beyond): Smolt will be collected by fyke net or weir to estimate the total out migration. Fish will be sampled to determine age, length and weight characteristics. Coded wire tags or thermal marking would be used to monitor the population. Returning adults will be enumerated at a weir on the outlet stream. Scales will also be collected and the age structure of the returning fish will be analyzed.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Personnel from the ADF&G Limnology Lab in Soldotna will conduct the limnological data collection, and the bathymetric mapping. ADF&G will also complete the water chemistry and plankton analysis laboratory work. USFS will conduct the habitat surveys, determine available spawning and rearing habitats, and evaluate the resident fish populations. Coordination will occur with PWSAC to make any necessary adjustments at the Main Bay Hatchery to accommodate additional incubation and short-term rearing. Coordination will also occur with PWSAC to perform any necessary fish culture work and to transport the fry to the lake.

SCHEDULE

A. Measurable Project Tasks for FY97

October:	Complete laboratory analysis of water chemistry and plankton data.
Nov. 1:	Evaluate FY96 results and prepare an updated proposal for Trustee Council.
Dec. 1 - Jan. 22:	Determine appropriate broodstock and address mixed-stock fisheries issue with Regional Planning Team. Begin public involvement for NEPA
January 22-25:	Attend Annual Restoration Workshop.
Feb. 1 - April 15:	Prepare for field season and evaluate upwelling sites at Columbia Lake. Complete NEPA.
April 15:	Submit annual report.
May 15 - Sept 15:	Limnological data collection.
June/July:	Resident fish population estimation (if necessary).
September:	Begin analysis of FY97 field data.

B. Project Milestones and Endpoints

Phase 1. The overall objective of this stage of the project is to determine the feasibility of stocking Columbia Lake with sockeye salmon. This objective will be completed when two years of limnological sampling are completed and analyzed (early FY98). However, results from sampling in 1996 will be used to provide preliminary findings for sub-objectives 1 and 2 (productivity potential and stocking levels) in time for the Trustee Council meeting in December. Coordination with PWSAC and Main Bay hatchery to determine an appropriate brood stock (sub-objective 3) can be based on the preliminary results from FY96.

Phase 2. This is the actual stocking phase of the project. Should the results of Phase 1 be favorable stocking could begin in FY99. The following is a tentative schedule and measureable endpoints that apply to this phase of the project.

FY97:	Determine appropriate brood stock and potential stocking levels.
June/July FY97:	Collect pathology samples (if needed)

Oct. 15 - Nov. 30; FY98:	Verify findings, present results to TC.
Jan. - March; FY98:	Apply for necessary permits and hatchery space; complete NEPA process.
June/July; FY98:	Collect eggs for brood stock.
FY99 - 2003:	Release hatchery-reared fry
	Monitor zooplankton population
	Monitor smolt out-migration (FY2000 - FY2003)
	Submit annual reports

C. Completion Date

The project completion date will be at the end of FY2003.

PUBLICATIONS AND REPORTS

Annual reports will be prepared during each year of the project and preliminary reports on the feasibility assessment will be provided to the Trustee Council in late November 1996 and in November 1997.

NORMAL AGENCY MANAGEMENT

Current budgets and Forest Service priorities would not provide the opportunity to conduct this project under our normal agency management in the near future. This project will produce the greatest benefit to subsistence users if the adult fish can be harvested in the foreseeable future.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Initial coordination with ADF&G biologists in Cordova, with the Regional Planning Team, and with PWSAC were begun in FY96 to address the mixed-stock fisheries and genetics issues that will influence the feasibility of this project. We will attend the summer or fall 1996 Regional Planning Team meeting to facilitate the necessary coordination. Once the initial results are available from FY96, the potential size of the stocking program and potential brood stocks can be identified. This information will be necessary to assess the potential effects of this project on local wild stocks and on the commercial fisheries in the area. Coordination with the Youth Area Watch Program (96210) was begun in 1996 to explore opportunities for future involvement with this project.

The limnological data collection at Columbia Lake will be coordinated with the collection of samples from Solf Lake (97256b). This will reduce the frequency and costs of airplane charters. The environmental analysis (NEPA compliance) will be combined with the Solf Lake project. One half of the anticipated time/cost needed for completion of the analysis and documentation is incorporated into this proposal.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This proposal covers only one of the two locations described in 96256. The proposal for the other site, Solf Lake on Knight Island, is being submitted as 97256b. This split occurred because the work schedule for FY97 differs substantially between Solf and Columbia Lakes.

The work described in this proposal for Columbia Lake also differs from the FY96 proposal in that a second field season is scheduled to collect limnological data, and additional field work may be required to determine resident fish population sizes. The second field season is recommended under ADF&Gs management plan (G.Kyle, personal communication) to evaluate lakes which have had no prior limnological collection data. The addition of the extra field season also delays the logical starting date to stock Columbia Lake from 1998 to 1999 and extends the duration of the project one year to 2003.

NEPA compliance and RPT approval were originally scheduled for FY96. Although coordination efforts with RPT began in 1996, information from the feasibility assessments are necessary before the RPT can approve the project. NEPA compliance must also occur after the first year of the feasibility assessment is completed so that the proposed action can be clearly described.

Field methods were not described in the 1996 project proposal; therefore, a brief description is provided in Appendix A of this proposal.

PROPOSED PRINCIPAL INVESTIGATOR

The principal investigator of this project will be the Fisheries Biologist at the Glacier Ranger District of the Chugach National Forest. This position is currently vacant and expected to be filled in FY96. Karen A. Murphy is the interim biologist and will coordinate this project for the USFS until a permanent principal investigator is assigned. Daniel Gillikin (Fisheries Biological Technician; Glacier Ranger District) will provide technical support and field coordination of the seasonal employees assisting in data collection for the project.

ADF&G is the cooperating agency on the project. Pat Shields, Fishery Biologist I, will be the principal investigator for the limnological and bathymetric work. Marsha Spafard, Fish and Game Technician III and Denise Cialek, Fish and Game Technician III, will assist in the data collection and laboratory analysis of the limnological data.

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LITERATURE CITED

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Wetzel, R.G. and G.E. Likens. 1979. Limnological Analyses. W.B. Saunders Company, Philadelphia, PA. 357 p.

PERSONAL COMMUNICATIONS

Holbrook, K., US Forest Service, Anchorage. August 1995.

Kyle, G.B., Limnologist, Alaska Department of Fish and Game. Div. of Comm. Fish. Mgmt. and Dev. Soldotna. 4-25-95; 4-2-96.

APPENDIX A

Limnological Sampling (1996 and 1997): Data collection and analysis will include: Algal biomass (chlorophyll a), zooplankton populations (biomass, body-sizes, species composition etc.), temperature and light profiles, dissolved oxygen, and water quality (nutrients) to estimate the potential productivity of the lake. Procedures for the collection of these samples are detailed in Koenings et. al. (1987). Samples would be collected from a minimum of two permanent collection sites every three to four weeks May - September to assess seasonal variation.

Fisheries and Macroinvertebrate Initial Sampling (1996): Sampling for fish populations already within the system will occur in July 1996. Sampling scheduled for 1996 is focused on determining what fish species may already be present in Columbia Lake. Until initial sampling occurs it is unknown if additional sampling would be required to establish population sizes of fish. Determining population sizes of fish populations in 1996 was not in the original proposal for FY96 and will be dependant upon funding, the availability of hydroacoustic equipment and on the results of the initial sampling.

Qualitative data on the exisiting fish and macroinvertebrate populations will be collected using a variety of methods. The intent is to determine the presence or absence of a particular species. Age classes, the strength of the different classes, and the condition factor for each particular species will be determined provided representative samples can be collected. Semi-quantitative estimates of relative fish abundance can also be made using catch per unit effort at the time of the survey. Macroinvertebrate sampling will focus on the inlet streams benthic communities and will assess the overall diversity by the presence or absence of various taxa. This initial sampling will also serve to establish baseline protocol for any future surveys to assess Columbia Lake.

The initial sampling techniques for fish species will include using fyke nets, variable mesh gill nets and baited minnow traps to collect fish at different depths throughout the lake and associated streams. Fyke nets will be used to sample for existing sockeye salmon populations on the NE and SE arms of the lakes where clearwater streams enter. At least 12 sites will be sampled in near shore and pelagic regions. Fyke nets may also be used to sample near the outlet if currents are not too strong. Baited minnow traps and larger tyvex traps will be used to sample for fish in the clearwater inlet streams and in the three small clearwater ponds which may, or may not, be accessible to fish. Pelagic regions of the lake will be sampled in a random pattern using a floating fyke net at three to seven meter depths. Variable mesh gillnets will also be used to trap for larger adult Dolly Varden char that are more difficult to capture in other traps. These gillnets will be set perpendicular to shore to sample varying depths.

Habitat surveys: Surveys will be conducted in 1996 on Columbia Lake, associated tributaries, and outflow streams to determine the availability of spawning and rearing habitats. Stream surveys will follow a modified Hankin and Reeves (1988) procedure which provides quantitative measurements of habitat types. Stream reaches are divided into habitat types based on flow patterns and channel bed shape (pools, riffles, glides etc). Physical parameters of the habitat types would be measured or estimated and descriptions of substrates and available cover will be

recorded. Water residence times will be determined using flow estimates made from the watershed based on procedures described in the Forest Service Water Resources Atlas (Blanchet, 1983). Direct stream flow measurements may be collected if the outlet stream can be sampled using gurley meters. Lake surveys will be focused on developing a shoreline map, identifying potential spawning areas and on available cover for rearing habitat.

Bathymetry: A bathymetric map of Columbia Lake will be developed in 1996 using sonar equipment to establish the basin contours (Wetzel and Likens, 1979). Information from the bathymetric map will be used in combination with limnological and habitat survey data to determine the potential productivity of Columbia Lake.

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997	PROPOSED FFY 1997 TRUSTEE AGENCIES TOTALS ADEC	ADF&G	ADNR	USFS	DOI	NOAA
Personnel	$41.2	$20.9						
Travel	$0.0	$1.5						
Contractual	$10.4	$7.2						
Commodities	$2.2	$1.2						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$53.8	$30.8	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
General Administration	$7.0	$3.6						
Project Total	$60.8	$34.4	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)	0.8	0.4						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Comments: This project is a continuation of 96256.

1997

Prepared:4/10/96, K. Holbrook

Project Number: 97256A
Project Title: Sockeye Salmon Stocking; Columbia Lake
Lead Agency: USFS

FORM 2A
MULTI-TRUSTEE
AGENCY SUMMARY

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Personnel	$31.4	$14.7						
Travel	$0.0	$1.5						
Contractual	$6.4	$0.0						
Commodities	$0.4	$0.3						
Equipment	$0.0	$0.0						
Subtotal	$38.2	$16.5						
General Administration	$5.2	$2.2						
Project Total	$43.4	$18.7						
Full-time Equivalents (FTE)	0.6	0.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1997

Prepared:

Project Number: 97256A
Project Title: Sockeye Salmon Stocking; Columbia Lake
Agency: USFS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1997
Vacant	Fish Biologist	GS-9	3.5	4.2		14.7
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		3.5	4.2	0.0	
					Personnel Total	$14.7

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
RT Anchorage to Cordova	200.0	2	2	225.0	850.0
RT Cordova to Tatitlek	200.0	1	2	225.0	650.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1,500.0

1997

Prepared:

Project Number: 97256A
Project Title: Sockeye Salmon Stocking; Columbia Lake
Agency: USFS

FORM 3B
Personnel
& Travel
DETAIL

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Contractual Costs:	Proposed
Description	FFY 1997
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FFY 1997
Printing	0.3
Commodities Total	$0.3

1997

Project Number:97256A
Project Title: Sockeye Salmon Stocking; Columbia Lake
Agency: USFS

FORM 3B
Contractual &
Commodities
DETAIL

Prepared:

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1997

Project Number: 97256A
Project Title: Sockeye Salmon Stocking; Columbia Lake
Agency: USFS

FORM 3B
Equipment
DETAIL

Prepared:

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Personnel	$9.8	$6.2						
Travel	$0.0	$0.0						
Contractual	$4.0	$7.2						
Commodities	$1.8	$0.9						
Equipment	$0.0	$0.0						
Subtotal	$15.6	$14.3						
General Administration	$1.8	$1.4						
Project Total	$17.4	$15.7						
Full-time Equivalents (FTE)	0.2	0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1997

Project Number: 97256A
Project Title: Sockeye Salmon Stocking; Columbia Lake
Agency: ADF&G

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: 4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1997
P. Shields	FBI	14F	0.7	4.8		3.4
Marsha. Spafard	FTIII	11D	0.6	3.4		2.0
Denise Clark	FTIII	11K	0.2	4.0		0.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.5	12.2	0.0	
					Personnel Total	$6.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

1997

Prepared:

Project Number: 97256A
Project Title: Sockeye Salmon Stocking; Columbia Lake
Agency: ADF&G

FORM 3B
Personnel
& Travel
DETAIL

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Contractual Costs:	Proposed
Description	FFY 1997
Air charter, (6 trips @ 950/trip, 2 trips@ $750)	7.2
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$7.2

Commodities Costs:	Proposed
Description	FFY 1997
misc sampling gear	0.5
lab supplies	0.4
Commodities Total	$0.9

1997

Prepared:

Project Number: 97256A
Project Title: Sockeye Salmon Stocking; Columbia Lake
Agency: ADF&G

FORM 3B
Contractual &
Commodities
DETAIL

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1997

Project Number: 97256A
Project Title: Sockeye Salmon Stocking; Columbia Lake
Agency: ADF&G

FORM 3B
Equipment
DETAIL

Prepared:

4/15/96

Sockeye Salmon Stocking at Solf Lake.

Project number:	97256b
Restoration Category:	General Restoration
Proposer:	USFS
Lead Trustee Agency:	USFS
Cooperating Agencies:	ADF&G
Duration:	2nd year, 7-year project
Cost FY 1997:	$16,800
Cost FY 1998:	TBD
Cost FY 1999:	TBD
Cost FY 2000:	TBD
Cost FY 2001:	TBD
Cost FY 2002:	TBD
Geographic Area:	Prince William Sound
Injured Resource:	Subsistence/Sockeye Salmon

ABSTRACT

This project is designed specifically to benefit subsistence users of Prince William Sound and especially for residents of Chenega Bay. Solf Lake has been recognized for many years as an opportunity to establish a self-sustaining sockeye salmon run. Habitat improvements were made in 1978, 1980 and 1981 to provide access to the lake for anadromous fish. The lake was never stocked and subsequent investigations suggest that it is currently fishless and has adequate zooplankton biomass to support a salmon population. There are two phases to this project: the feasibility phase (FY96) will verify the ability of Solf Lake to support a population of sockeye salmon. Phase 2 would be to stock the lake with sockeye salmon and ensure adequate anadromous access to the lake. If the project is found to be feasible, stocking of the lake could begin in 1998.

INTRODUCTION

Subsistence resources and services were injured throughout Prince William Sound as a result of the *Exxon Valdez* Oil Spill. This project proposal continues an investigation of the potential to improve subsistence opportunities through the stocking of sockeye salmon (*Oncorhynchus nerka*) in Solf Lake, Herring Bay, in Prince William Sound (PWS). Solf Lake has been recognized as an opportunity for establishing a self-sustaining sockeye salmon population since the 1960s. The lake now provides an excellent opportunity to establish a replacement fishery to benefit subsistence users in Prince William Sound, particularly for residents of Chenega Bay. In addition to benefiting subsistence users, establishing a self-sustaining sockeye salmon population in this lake would also provide benefits to sport fisheries.

This 1996 project began as a feasibility assessment. In Fiscal Year 1996 (FY96) the Trustee Council funded project 96256 which was a combined proposal to assess the feasibility of stocking programs at Columbia Lake and at Solf Lake on Knight Island. These proposals have been split into 97256a (Columbia Lake) and 97256b (Solf Lake) because the anticipated work needed in 1997 differs significantly between the two locations. Preliminary results and recommendations from the feasibility phase of this project will be available in December 1996 for the Trustee Council to determine if stocking could begin in 1998. This proposal describes the preparatory work in 1997 that will be needed to begin a stocking program in 1998. Because the field work associated with the feasibility assessment will not be completed until September of 1996, we are unable to provide a detailed proposal at this time. An updated detailed project proposal will be provided once the results from the 1996 season have been analyzed.

Although Solf Lake was once accessible to sockeye salmon, an earthquake in the 1930's blocked the access channel (Nickerson, 1978). For many years Dolly Varden were the only known resident fish. In 1978 the Forest Service removed the barriers from the old access channel and created a dam at the existing outlet to provide adequate stream flows in the new outlet channel to provide access for sockeye salmon. Improvements to the new outlet channel and dam were made in 1980 and 1981 but the system was never stocked with salmon. The feasibility phase of the project (FY96) will include investigations of zooplankton and algal biomass, temperature and light profiles, dissolved oxygen and water chemistry as well as an inventory of fish and macro-invertebrate populations and available habitats. The habitat improvement structures will also be evaluated to determine if the access to the lake is adequate. Analysis of the limnological samples will begin in August of 1996 and are expected to be completed by November 1996. The results of the analyses from FY96 will be analyzed along with limnological data collected in 1982, 1984, and 1986 to determine if the lake is capable of sustaining a sockeye salmon population.

The lake is included in the Prince William Sound - Copper River Comprehensive Salmon Plan (PWSRPT, 1994) where it is recommended for implementation if funds become available. In April 1995 the original proposal for this project was presented to the Prince William Sound/Copper River Regional Fisheries Planning Team for consideration and approval. They recommended that an RPT checklist be completed and that the project be coordinated with Alaska Department of Fish and Game (ADF&G) and Prince William Sound Aquaculture

Corporation (PWSAC) to obtain required permits and hatchery space and to resolve mixed-stock fisheries issues. These tasks are to be completed in 1996.

NEED FOR THE PROJECT

A. Statement of Problem

Subsistence use of resources in the oil spill area declined following the spill. Although restoration studies have shown that harvest levels have since returned to prespill levels in most oil spill communities, Chenega Bay and Tatitlek are exceptions (Seitz and Fall, 1995; Seitz and Miraglia, 1995). These communities showed reduced harvest levels in 1993/94 and an increased reliance on salmon harvests (Seitz and Fall, 1995; Seitz and Miraglia, 1995). Solf Lake provides an opportunity to establish a large replacement fishery that is easily accessible for subsistence users from Chenega Bay. Projects available for the restoration or replacement of lost subsistence services are limited - this proposal would utilize one of the few opportunities available.

This project determines the feasibility of stocking Solf Lake with sockeye salmon as a replacement fishery for subsistence use. Based on historical limnological data from the 1980's, there is reason to expect that the lake is capable of supporting a sockeye population with an adult return of approximately 19,000. However, additional information on the lake are needed to assess the ability of the lake to support a self-sustaining sockeye population.

B. Rationale/Link to Restoration

The *Exxon Valdez* Restoration Office's Invitation to submit proposals for FY97 stated that subsistence users are traveling greater distances and must invest more time in subsistence harvesting than they did prior to the spill. Unlike many other oil spill communities, Chenega Bay still shows reduced subsistence harvest levels and a greater reliance on subsistence harvest of salmon (Seitz and Fall, 1995; Seitz and Miraglia, 1995). Solf Lake is located approximately 40 miles from Chenega Bay and provides an opportunity to establish a replacement fishery that is accessible to subsistence users. The lake is a clearwater lake with a mean depth of 42.5 m and a surface area of approximately 0.61 km^2 (Barto and Nelson, 1982). Initial estimates suggest that the lake may support a population of 19,000 returning adults. Establishing this fishery would directly benefit subsistence users in Prince William Sound.

Background. Solf lake has been recognized as an opportunity to re-establish a sockeye salmon run in Prince William Sound for many years. According to Nickerson (1978), "This system had historic runs of sockeye salmon. An earthquake in the 1930's caused blockages of the natural outlet resulting in water flowing over an impassable fall." Since the early 1970's various attempts have been made to reestablish sockeye salmon in Solf Lake. During two years in the early 1970's, ADF&G personnel transported adult sockeye salmon from Eshamy River to Solf Lake (Jackson, personal communication). Unfortunately, necessary stream improvements had not been completed when the transplanted fish returned. The attempt to reestablish the population failed. In 1978, 1980 and 1981, the USFS implemented improvements to the lake and

outlet stream. The work consisted of creating a new outlet channel, and a partial dam at the existing outlet. The dam was designed to raise the level of the lake to provide adequate water flow through the newly created outlet. The new outlet channel is less than 100 meters in length with an average gradient of 23 percent. Stocking of the lake never occurred after the habitat improvements because of other priority projects for both the USFS and ADF&G.

ADF&G surveyed Solf Lake in 1985/1986 as part of a lake investigations study. The results of this survey, which included attempts to capture fish, suggest that the lake may be fishless (Pellissier and Somerville, 1987). These results are also supported by the composition and biomass of the zooplankton populations which were last sampled in 1986 (P. Shields, personal communication 1996). The Pellissier and Somerville (1987) survey also documented that water was flowing through the original outlet where an incomplete seal in the dam structure occurred. Three minor barriers to fish passage were identified in the created outlet channel. The report suggests that if all the outlet flow were directed down the created channel these barriers may disappear.

The feasibility assessment stage of this project will occur during the summer of 1996. The condition of the outlet channel and lake dam structure will be evaluated and recommendations for any needed repairs would be made. Limnological samples will be taken to supplement data previously collected. Coordination with the PWS/CR Regional Fisheries Planning Team will also occur as part of the feasibility study to address mixed stocked fisheries issues as well as potential genetic effects on local wild stocks.

C. Location

Solf Lake is located off of Herring Bay on Knight Island. The lake is approximately 40 miles by boat from Chenega Bay and 46 miles from Whittier. The lake is unnamed on USGS maps; however, Nickerson (1978), PWSRPT (1983 and 1986) and Barto and Nelson (1982) all refer to the lake as Solf Lake (ADF&G Stream 690). The lake is described in the Anadromous Waters Catalog as number 226-10-16900-0010 (ADF&G, 1992).

COMMUNITY INVOLVEMENT

This project is designed specifically to benefit subsistence users of PWS; therefore, community involvement is an important component for the success of the project. The feasibility phase of this project (FY96) will determine the ability of Solf Lake to support a resident population of sockeye salmon. Contacts with the Chenega Bay community liaison will be maintained throughout the feasibility phase of this project to discuss the results of the limnological investigation and explain what the potential adult sockeye production might be for the lake. Opportunities will be identified to include residents of Chenega Bay in habitat improvement work or in the post-stocking monitoring program. Coordination with the Youth Area Watch Program (96210) was begun in 1996 to explore the possibilities of future involvement with this project.

PROJECT DESIGN

A. Objectives

Phase 1. The overall objective of this project is to determine the feasibility of stocking Solf Lake with sockeye salmon. There are four components of this objective:

1. determine if Solf Lake can sustain a population of sockeye salmon;
2. determine appropriate stocking levels that could be sustained; and,
3. coordinate with PWSAC and Main Bay hatchery to establish an appropriate brood stock and the necessary logistics to begin a stocking program.
4. evaluate the existing habitat improvement structures to ensure adequate conditions for adult migration.

Phase 2. This is the actual stocking stage of the project and is dependant upon the outcome of Phase 1. There are two objectives to this phase of the project.

1. Make necessary improvements to the outlet channel and/or the dam to ensure adequate passage for adult migration.
2. Stock Solf lake with sockeye salmon to produce a self-sustaining population that can provide an adequate subsistence harvest.

B. Methods

Project 96256 included one season of data collection to determine presence of resident fish and the potential carrying capacity of Solf Lake. At this time it appears prudent to collect a second year of limnological data in 1997 at Solf Lake. This would be a cost effective effort when coordinated with flights for similar activities at Columbia Lake. These additional data combined with previous limnological data collected at Solf Lake will be used to determine the feasibility of stocking the lake. The feasibility assessment will also identify if additional habitat improvements will be needed to sustain a sockeye salmon run. The following section is divided into two parts. Part 1 describes the methods needed to establish a self-sustaining sockeye salmon population - assuming that the lake is capable of supporting such a population. Part 2 describes the possible types of habitat improvements that may be needed to provide access for returning adult salmon. Sampling methods scheduled for use in 1996 are also attached to this proposal as Appendix A.

Part 1. This section outlines the methods to implement a stocking program in Solf Lake.

Interagency Coordination (1997): Close coordination between the USFS, ADF&G, PWSAC and the PWS/CR RPT is mandatory for the success of this project. Prince William Sound is a complex ecosystem and the potential stocking of Solf Lake needs to be considered in perspective with the overall management of the Sound. Interagency coordination will occur in 1996 and 1997 to identify appropriate brood stocks, determine appropriate stocking levels, meet hatchery-related requirements, and to address mixed-stock fisheries issues. These issues will also be addressed under an Environmental Assessment in 1997.

Stocking Program (1998 to 2002): Appropriate stocking levels and strategies will be determined in coordination with ADF&G and PWSAC using all available data. If the decision is made to stock the lake, fry would be short-term reared at the Main Bay Hatchery and transported to the lake for release. The Eyak and Coghill stocks are identified in the PWS/CR Phase 3 Comprehensive Salmon Plan (PWS/CR RPT, 1994) as potential stocks for Solf Lake. Based on current information, 1998 would be the earliest release date possible, but the actual release time will be dependent upon space availability at Main Bay and/or ice cover and other conditions at the lake. At least four years of fry transplants would be required to establish a sockeye salmon run.

Monitoring (1998 and beyond): Limnological data will be collected each year of the stocking program to evaluate the affect of the stocking program on the plankton population. This monitoring will include a summer and fall sampling period for water chemistry analysis and monthly zooplankton sampling from May through September. These procedures are described in detail in Koenings et. al. (1987). This would be a reduced sampling design from the one used during the feasibility assessment of the lake.

The success of the stocking program would also be monitored through sampling the fish population during the smolt out migration and during adult escapement. Smolt will be collected by fyke net or weir to estimate the total out migration. Fish will be sampled to determine age, length and weight characteristics which can be used to evaluate the health of the population. Coded wire tags or thermal marking would be used to monitor the adult population. Returning adults will be enumerated at a weir on the outlet stream. Scales will also be collected and the age structure of the returning fish will be analyzed.

Part 2. This section recognizes that additional work may be needed to provide access to the lake for returning adults. Until the feasibility assessment is completed in 1996, it is unknown what type of work may be needed to ensure salmon have access to the lake. The information gained from the feasibility assessment will also be used to determine if any of the additional work should be covered under the normal agency management of the Forest Service. The methodologies outlined below would be in addition to those described in Part 1.

Solf Lake was visited by ADF&G personnel as part of a PWS lake investigations project in 1985 (Pellissier and Somerville, 1987). Three minor barriers to fish migration were identified in the outlet channel. These barriers were velocity barriers that ranged in size from 1.5 to 2.5 meters. The barriers may potentially be removed through the creation of plunge pools or by installing steeppasses. The report also suggested that the barriers may not exist if more water were in the outlet channel which could be achieved by repairing or rebuilding the dam at the waterfall of the original outlet channel. The actual methodologies used will be dependent upon the results of the habitat evaluation from 1996.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Personnel from the ADF&G Limnology Lab in Soldotna will conduct the limnological data collection. ADF&G will also complete the water chemistry and plankton analysis laboratory

work. USFS will conduct the habitat surveys, evaluations of the habitat improvement structures, determine available spawning and rearing habitats, and evaluate the resident fish populations. Coordination will occur with PWSAC to make any necessary adjustments at the Main Bay Hatchery to accommodate additional incubation and short-term rearing. Coordination will also occur with PWSAC to perform any necessary fish culture work and transport the fry to the lake. Interagency coordination is essential to establish a successful population at Solf Lake. The PWS/CR RPT will be involved in assessing opportunities and for developing strategies for the stocking program.

SCHEDULE

A. Measurable Project Tasks for FY97

Oct - Dec. FY97:	Determine appropriate brood stock and potential stocking levels. Coordinate with PWSAC and the PWSRPT for production planning. Complete laboratory analysis of water chemistry and plankton data.
Nov. 1:	Evaluate FY96 results and prepare an updated proposal for Trustee Council.
Dec. 1 - Jan. 22:	Begin public involvement for NEPA
January 22-25:	Attend Annual Restoration Workshop.
Feb. 1 - April 15:	Prepare for field season.
April 15:	Submit annual report.
June - July:	Begin maintenance or installation of habitat improvement structures (Part 2 - if needed; this work would need to be completed before the first adult fish returned to the lake.) Obtain eggs for hatchery incubation.

B. Project Milestones and Endpoints

Phase 1. The overall objective of this stage of the project is to determine the feasibility of stocking Solf Lake with sockeye salmon. This objective will be completed when limnological samples are collected and analyzed; and mixed-stock fisheries and genetic risk issues are resolved. This objective will be completed in early FY97.

Phase 2. This is the actual stocking phase of the project. Should the results of Phase 1 be favorable stocking could begin in FY98. However, if the evaluation of the habitat structures at Solf Lake indicate that additional work is needed to allow for adequate fish passage, these improvements would have to be made before adult fish are expected to return to the lake. The following is a tentative schedule and measurable endpoints that apply to this phase of the project.

Oct - Dec. FY97:	Determine appropriate brood stock and potential stocking levels. Coordinate with PWSAC and the PWSRPT for production planning.
Jan. - April FY98:	Apply for necessary permits and hatchery space; complete NEPA process; prepare for field season.

May - July:	Design and implement necessary habitat improvements (if needed).
June/July:	Collect eggs for brood stock.
FY98 - 2002:	Release hatchery-reared fry
	Monitor zooplankton population
	Monitor smolt out-migration (FY2000 - FY2003)
	Submit annual reports
FY2002:	Enumerate adult returns

C. Completion Date

The project completion date will be at the end of FY2003.

PUBLICATIONS AND REPORTS

Annual reports will be prepared during each year of the project and preliminary reports on the feasibility assessment will be provided to the Trustee Council in late November 1996.

NORMAL AGENCY MANAGEMENT

Current budgets and agency priorities would not provide the opportunity to conduct the project under normal agency management in the near future. However, some aspects of the repair of existing habitat improvement structures, or the installation of new structures, may fall under the normal agency management of the Forest Service. These opportunities will be evaluated as part of the feasibility stage of this project (1996).

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Initial coordination with ADF&G biologists in Cordova, with the Regional Planning Team, and with PWSAC will continue throughout FY96 to address the mixed-stock fisheries and genetic risk issues that will influence the feasibility of this project. We will attend the summer or fall 1996 Regional Planning Team meeting to facilitate the necessary coordination. Once the initial results are available from FY96, the potential size of the stocking program and potential brood stocks can be identified. This information will be necessary to assess the potential effects of this project on local wild stocks and on the commercial fisheries in the area. Coordination with the Youth Area Watch Program (96210) was begun in 1996 to explore opportunities for future involvement with this project in repairing habitat improvement structures and in monitoring the fish population.

The limnological data collection for monitoring at Solf Lake will be coordinated with the collection of samples from Columbia Lake (97256b). This will reduce the number and costs of the airplane charters. A portion of the development of an environmental assessment (NEPA compliance) can be combined with the NEPA compliance needed for the Columbia Lake project.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This proposal covers only one of the two locations described in 96256. The proposal for the other site, Columbia Lake, is being submitted as 97256a. This split occurred because the work schedule for FY97 differs substantially between Solf and Columbia Lakes.

Field methods were not described in the 1996 project proposal; therefore, a brief description is provided in Appendix A of this proposal.

PROPOSED PRINCIPAL INVESTIGATOR

The principal investigator of this project will be the Fisheries Biologist at the Glacier Ranger District of the Chugach National Forest. This position is currently vacant and expected to be filled in FY96. Karen A. Murphy is the interim biologist and will coordinate this project for the USFS until a permanent principal investigator is assigned. Daniel Gillikin (Fisheries Biological Technician; Glacier Ranger District) will provide technical support and field coordination of the seasonal employees assisting in data collection for the project.

ADF&G is the cooperating agency on the project. Pat Shields, Fishery Biologist I, will be the principal investigator for the limnological and bathimetry work. Marsha Spafard, Fish and Game Technician III and Denise Cialek, Fish and Game Technician III, will assist in the data collection and laboratory analysis of the limnological data.

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APPENDIX A

Limnological Sampling (1996-1997): Data collection and analysis will include: Algal biomass (chlorophyll a), zooplankton populations (biomass, body-sizes, species composition etc.), temperature and light profiles, dissolved oxygen, and water quality (nutrients) to estimate the potential productivity of the lake. Procedures for the collection of these samples are detailed in Koenings et. al. (1987). Samples would be collected from a minimum of two permanent collection sites every three to four weeks May - September to assess seasonal variation.

Fisheries and Macroinvertebrate Initial Sampling (1996): Sampling for resident fish populations already within the system will occur in July 1996. Sampling scheduled for 1996 is focused on determining what fish species may already be present in Solf Lake. Until initial sampling occurs it is unknown if additional sampling would be required to establish population sizes.

Qualitative data on the existing fish and macroinvertebrate populations will be collected using a variety of methods. The intent is to determine the presence or absence of a particular species. Age cl
ses, the strength of the different classes, and the condition factor for each particular species will be determined provided representative samples can be collected. Semi-quantitative estimates of relative fish abundance can also be made using catch per unit effort at the time of the survey.

The initial sampling techniques for fish species will include using fyke nets, variable mesh gill nets and baited minnow traps to collect fish at different depths throughout the lake and associated streams. Baited minnow traps and larger tyvex traps will be used to sample for fish in the clearwater inlet streams and in the three small clearwater ponds which may, or may not, be accessible to fish. Pelagic regions of the lake will be sampled in a random pattern using a floating fyke net at three to seven meter depths. Variable mesh gillnets will also be used to trap for larger adult Dolly Varden char that are more difficult to capture in other traps. These gillnets will be set perpendicular to shore to sample varying depths.

Habitat surveys: Surveys will be conducted in 1996 on Solf Lake, and outflow streams to determine the availability of spawning and rearing habitats. Stream surveys will follow a modified Hankin and Reeves (1988) procedure which provides quantitative measurements of habitat types. Stream reaches are divided into habitat types based on flow patterns and channel bed shape (pools, riffles, glides etc). Physical parameters of the habitat types would be measured or estimated and descriptions of substrates and available cover will be recorded. Water residence times will be determined using flow estimates made from the watershed based on procedures described in the Forest Service Water Resources Atlas (Blanchet, 1983). Lake surveys will be focused on developing a shoreline map, identifying potential spawning areas and on available cover for rearing habitat.

1997 EXXON VALDEZ TRUS[illegible] COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997	PROPOSED FFY 1997 TRUSTEE AGENCIES TOTALS ADEC	ADF&G	ADNR	USFS	DOI	NOAA
Personnel	$41.2	$12.9						
Travel	$0.0	$0.0						
Contractual	$10.4	$1.5						
Commodities	$2.2	$0.3						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$53.8	$14.7	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
General Administration	$7.0	$2.1						
Project Total	$60.8	$16.8	#VALUE!	$0.0	$0.0	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)	0.8	0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Comments: This project is a continuation of 96256.

1997

Prepared:4/10/96

Project Number: 97256B
Project Title: Sockeye Salmon Stocking; Solf Lake
Lead Agency: USFS

FORM 2A
MULTI-TRUSTEE
AGENCY SUMMARY

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Personnel	$31.4	$10.5						
Travel	$0.0	$0.0						
Contractual	$6.4	$0.0						
Commodities	$0.4	$0.3						
Equipment	$0.0	$0.0						
Subtotal	$38.2	$10.8						
General Administration	$5.2	$1.6						
Project Total	$43.4	$12.4						
Full-time Equivalents (FTE)	0.6	0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: This project is a continuation of 96256.

1997

Prepared:

Project Number: 97256B
Project Title: Sockeye Salmon Stocking; Solf Lake
Agency: USFS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1997
Vacant	Fish Biologist	GS-9	2.5	4.2		10.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.5	4.2	0.0	
					Personnel Total	$10.5

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

1997

Prepared:

Project Number: 97256B
Project Title: Sockeye Salmon Stocking; Solf Lake
Agency: USFS

FORM 3B
Personnel
& Travel
DETAIL

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Contractual Costs:	Proposed
Description	FFY 1997
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FFY 1997
Printing	0.3
Commodities Total	$0.3

1997

Project Number: 97256B
Project Title: Sockeye Salmon Stocking; Solf Lake
Agency: USFS

FORM 3B
Contractual & Commodities DETAIL

Prepared:

4/15/96

1997 EXXON VALDEZ TRUS[illegible] COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1997

Project Number: 97256B
Project Title: Sockeye Salmon Stocking; Solf Lake
Agency: USFS

FORM 3B
Equipment
DETAIL

Prepared:

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Personnel	$9.8	$2.4						
Travel	$0.0	$0.0						
Contractual	$4.0	$1.5						
Commodities	$1.8	$0.0						
Equipment	$0.0	$0.0						
Subtotal	$15.6	$3.9						
General Administration	$1.8	$0.5						
Project Total	$17.4	$4.4	TBD					
Full-time Equivalents (FTE)	0.2	0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1997

Prepared:

Project Number: 97256B
Project Title: Sockeye Salmon Stocking; Solf Lake
Agency: ADF&G

FORM 3A
TRUSTEE
AGENCY
SUMMARY
4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1997
Pat Shields	FBI	14F	0.5	4.8		2.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.5	4.8	0.0	
					Personnel Total	$2.4

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

1997

Prepared:

Project Number: 97256B
Project Title: Sockeye Salmon Stocking; Solf Lake
Agency: ADF&G

FORM 3B
Personnel
& Travel
DETAIL

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Contractual Costs:	Proposed FFY 1997
Description	
Air Charter ($250/hour for 6 hours)	1.5
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$1.5

Commodities Costs:	Proposed FFY 1997
Description	
Commodities Total	$0.0

1997

Project Number: 97256B
Project Title: Sockeye Salmon Stocking; Solf Lake
Agency: ADF&G

FORM 3B
Contractual & Commodities DETAIL

Prepared: 4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1997

Project Number: 97256B
Project Title: Sockeye Salmon Stocking; Solf Lake
Agency: ADF&G

FORM 3B
Equipment
DETAIL

Prepared:

4/15/96

Sockeye Salmon Overescapement Project
FY 97 Detailed Project Description
Submitted under the BAA

Project Number:	97258
Restoration Category:	Monitoring/Restoration
Proposer:	Alaska Department of Fish and Game
Lead Trustee Agency:	Alaska Department of Fish and Game
Cooperating Agencies:	U.S.F.W.S, N.B.S., Department of Interior
Duration:	7th year-10 year project
Cost FY 97:	$289,900 (closeout Kodiak)
Cost FY 98:	$250,000
Cost FY 99:	$250,000
Cost FY 00	$20,000
Geographic Area:	Kenai Peninsula and Kodiak Island
Injured Resource/Service:	This project is intended to evaluate the impacts of the large 1989 escapements on salmon runs returning to Cook Inlet and Kodiak Island and to develop restoration strategies.

ABSTRACT

This proposal provides for a close-out budget for the Kodiak Island sockeye salmon studies with a limited monitoring program for Kenai River sockeye salmon. Proposal tasks includes final report preparation on the Kodiak lake systems including analysis of samples collected in FY96. The Kenai studies will focus on evaluation of the existing data and continue a limited monitoring program of the key variables affecting sockeye salmon production Our hypotheses was presented in the 1996 annual report. Most of the funding will be directed at completing the FY96 sample analysis and evaluation of the existing data base. These studies are developing production models for restoration of the system.

INTRODUCTION

This study is a continuation of the oil spill damage assessment program initiated in 1990 (Schmidt and Tarbox, 1993; 1994; 1995; 1996). The program presented reflects a major reduction in the scope of the investigations and major modifications based on the FY96 study results. The Kodiak system has been removed from these investigations with only funding for completion of sample analysis from the 1996 field season and final report preparation. Akalura Lake, not currently recovered, will be addressed in a separate restoration proposal prepared by the Kodiak staff .

The Kenai River glacial lakes have been studied intensely since 1991 with limited data collected prior to the 1989 oil spill. Adult sockeye salmon returns from the 1989 year class occurred primarily in 1994. However, our studies have observed a delay of at least one year in the response of adult returns to high escapements and this was seen in the 1995 adult return.

The limnological analyses (Schmidt and Tarbox 1996) have established the biological mechanism for the observed one year delay and also provided suggestions that an additional impact may occur by limiting zooplankton productivity an additional two years We described in an earlier publication based on the preliminary results of this work potentially predator resistant mechanisms ascribed to copepods from the literature, which may limit energy transfer but may be relatively independent of changes in standing crop biomass (Schmidt et al. 1994). We focused on induction of diel vertical migration behavior by either natural selection or a density dependent behavior response as a possible means of causing decreased growth rates in Skilak Lake fry when spawner densities increased. We lacked pre-spill data on DVM in Skilak Lake so our studies were limited to comparisons between Skilak and Tustumena lakes. These data support DVM as a possible mechanism for accounting for the differences in growth rates (as reflected by fall fry mean weight) between these lakes but did not provide a direct test of the hypothesis that growth rates (and consequently density dependent recruitment and survival) have changed in Skilak Lake as a consequence of increases in fry density causing zooplankton to become less efficiently consumed. The 1995 analysis provided further support to the effects of density on copepod distribution but suggested that the major variation observed in adult returns is most likely caused by highly variable recruitment within the lakes, rather than poor fall condition and decreased over wintering survival (Schmidt and Tarbox 1996).

We would expect this mechanism to occur only following highly successful year classes, as the recruited fry will effectively decrease future zooplankton production. Large escapements that fail to recruit would not have this impact. Larger than normal escapements in 1992, following normal escapements in 1990 and 1991 would be expected to coincide with the recovering zooplankton community, creating high numbers of fall fry and consequently large adult returns in 1997. Therefore, we have a proposed mechanism where high escapements may impact adult returns 8 years after the actual escapement event. Development of these ideas through baseline sampling programs of zooplankton and sockeye salmon spring and fall fry will provide the essential elements in defining an ecosystem based model for the Kenai River. This model will be the basis to insure restoration of productivity of this system in the future and will provide tools to evaluate options in the case of future oil spills or other management options that result in large

escapements to the Kenai River.

The proposed studies will follow the zooplankton community in Skilak and Kenai lakes through 1998 and monitor fall and spring fry abundance within the lakes. Increased spatial coverage should provide adequate definition of the multiple cohorts of *Cyclops* during the summer. The spatial segregation of the cohorts within the lake during this time period has required increased sampling precision. However, diel vertical distribution studies will be deleted from the existing sampling program. In addition, intensive sampling fry throughout the summer is no longer required with normal fall and spring sampling with hydroacoustic abundance estimates providing sufficient information.

NEED FOR THE PROJECT

A. Statement of Problem

The 1988, 1989, and 1990 brood years have resulted in adult returns that are the three lowest recruit per spawner values in the escapement history of Kenai River stocks. The 1995 studies have provided a major breakthrough in understanding the mechanism that regulates freshwater recruitment, and consequently much of the variability in the adult returns. The proposed program is a major reduction in the scope of these projects and closes out the Kodiak investigations. The largest remaining question concerning the impacts of the 1989 oil spill on Kenai River sockeye salmon production involve potential impacts on the productivity of the zooplankton community. The two year life cycle of the dominant zooplankton taxa, suggests that a single year class of sockeye salmon may have impacts on the zooplankton which primarily effects the recruitment of the subsequent year class. This life history may also impact the zooplankton reproduction and consequently affect zooplankton recruitment and sockeye recruitment three years later. The full effect of large escapements may be eight years after the initial large escapement event. Either adjacent year interaction and/or the three year lag effect on copepod reproduction can contribute to the establishment of cyclic dominance in the sockeye salmon returns. Although the adjacent year interaction is established by the existing data, an extension of the time series is important to determine if the cropping effect on copepod recruitment results in impacts on future sockeye salmon fry recruitment. In addition, adult returns from 1996 and 1997 should help determine the predictability of fall fry in estimating adult returns and also help define marine density based mortality.

The studies will also complete sample and data analysis of the 1996 field data collection program and produce a final report for the Kodiak Island Lakes. In addition, much of the effort will be focused on completion of the existing analyses for the Kenai River system and development of a production model that can be used in responding to future fishery closures. We will provide a basis for evaluation of other glacial lake sockeye salmon systems such as Coghill lake in PWS or the Chilkoot system in southeastern Alaska.

B. Rationale/Link to Restoration

With some exceptions, sockeye salmon production is limited by the area and quality of the rearing habitat of nursery lakes. Very few systems are limited by lack of spawning habitat. Consequently as escapements increase, numbers of fry will increase in the rearing lake until this rearing habitat is exceeded. Depending upon the nature of the system, the recruitment of smolt from these systems may plateau or decline as the carrying capacity is exceeded. Our studies have provided a mechanism for the primary effect observed in the fall fry abundance as well as the time lag observed in adult recruit per spawner data (Schmidt and Tarbox 1996). We have evidence that exceeding the carrying capacity of the lakes will be primarily be demonstrated through reduced recruitment of juvenile salmon from the following year class. Although this mechanism is well defined for adjacent year class interactive affects, reduction in the reproductive potential of the zooplankton is hypothesized to further reduce subsequent year class strength. In addition, the measurement of spring fry abundance will continue to monitor over-winter survival of each year class.

This study uses an approach recently emulated by the Sound Ecosystem Assessment (SEA) project in the marine environment. This is a holistic ecosystem based approach to evaluation of sockeye salmon production. By understanding the bottom-up and top-down trophic interactions in the nursery lakes we can explain much of the seemingly unexplainable patterns observed in adult recruit per spawner data. By obtaining this understanding, management activities that alter the number of spawners in this system can be evaluated relative to sustained yield management. These data will prove invaluable in the future for the Board of Fisheries to act prudently in both conservation and allocation decisions on the Kenai River. These data also provide an excellent baseline to assess the impacts of habitat alterations from logging and other human disturbances in the upper Kenai River basin.

On the Kenai Peninsula, the 1996 adult returns are expected to be relatively low but recruit per spawner values should increase. Based on the fall fry abundance data from brood year 1992, the 1997 run should be very strong and will be a reasonable test of the predictive qualities of our current model. A limited monitoring program of the juvenile salmon and the key limnology parameters of the Kenai River glacial lakes over the next two years should resolve the outstanding questions concerning the recruitment process and will complete the full monitoring cycle of the recovery process.

Because the current investigations (Schmidt and Tarbox 1996) not only establish the density dependent response in adult returns to the Kenai, following the 1989 oil spill, we have also developed a reasonable model that explains what factors limit production in glacial lake ecosystems. The proposed investigations are the final phase out of this program and provide for a cost-effective solution to resolve remaining issues and to complete analysis of all existing data.

Location

Study locations are on the Kenai Peninsula. Specific sampling locations are identified in Schmidt and Tarbox (1993). The project benefits will be accrued by residents of the Kenai Peninsula as well as the residents of the railbelt area who use Kenai River fisheries.

COMMUNITY INVOLVEMENT

Residents of the Kenai Peninsula Borough are an important part of the Trustee Council funded Kenai River restoration projects. Besides working on the projects in direct employment as ADF&G Fish and Wildlife biologist and technicians the people of the Peninsula are kept well informed about these projects. Major media outlets in Anchorage and Kenai cover the issues impacting the Kenai River, including the EVOS funded projects. In addition, local ADF&G project biologists have made presentations on restoration efforts to local governments, in local schools , and to community groups. Further, detailed discussions and program suggestions have resulted from the involvement of the Upper Cook Inlet Regional Planning Team. This team is composed of members from the Cook Inlet Regional Aquaculture Association and ADF&G. The team has held numerous meetings with diverse public participation to discuss the results to date of the EVOS Kenai River projects. Key portions of the 1995 studies were presented at the January, 1996 symposium and at the Board of Fisheries meeting. In addition presentations were made to the Soldotna Rotary Club and recent meetings of the regional planning team. Extensive statewide news coverage of these studies and radio interviews were provided. The study has had continuous public exposure and input from all segments of the public.

PROJECT DESIGN

Commercial fishing for sockeye salmon in 1989 was curtailed in UCI, the outer Chignik districts, and the Kodiak areas due to presence of oil in the fishing areas from the EVOS. As a result, the number of sockeye salmon entering four important sockeye producing systems (Kenai/Skilak, Chignik/Black, Red, and Frazer Lakes) and two less important lake systems (Akalura and Afognak or Litnik lakes) greatly exceeded levels that are thought to be most productive. Sockeye salmon spawn in lake associated river systems. Adult salmon serve an extremely important role in the ecosystem, providing food for marine mammals, terrestrial mammals, and birds. Additionally, carcass decomposition serves to charge fresh water lake systems with important nutrients. Juvenile salmon which rear in lakes for one or two years serve as a food source for a variety of fish and mammals. Sockeye salmon are also an important subsistence, sport, and commercial species. The ex-vessel value of the commercial catch of sockeye from these lake systems has averaged about $42 million per year since 1979, with the 1988 catch worth $115 million. Sockeye salmon returns to the Kenai River system support some of the largest recreational fisheries in the State.

Overly large spawning escapements may result in poor returns by producing more rearing juvenile sockeye than can be supported by the nursery lake's productivity (Kyle et al. 1988). In general, when rearing fish abundance greatly exceeds the lake's carrying capacity, prey resources are altered by changes in species and size composition (Mills and Schiavone 1982, Koenings and Burkett 1987, Kyle et al. 1988) with concomitant effects on all trophic levels (Carpenter et al. 1985). Because of such changes, juvenile sockeye growth is reduced, mortality increases, larger percentages holdover for another year of rearing; and the poor quality of smolts increases marine mortality. Where escapements are two to three times normal levels, the resulting high juvenile

densities crop the prey resources to the extent that more than one year is required to return to normal productivity. Rearing juveniles from subsequent brood-years suffer from both the poor quality of forage and from the increased competition for food by holdover juveniles (Townsend 1989; Koenings and Kyle 1991). This is the brood-year interaction underlying cyclic variation in the year class strength of anadromous fish.

The 1995 investigations have provided much improved insight into the recruitment process. First we established that the copepod, *Cyclops columbianus* is dominant zoopolanktor in the lakes and in the diet of rearing juvenile sockeye salmon. This species has a two year life cycle with reproduction limited two its second year of life with 20-40 eggs per female being produced. A strong correlation exists with the spring abundance of this species and subsequent recruitment of fall fry. The spring *Cyclops* are all age-1 and are survivors from sockeye salmon predation from the previous year. In addition, this population provides all of the reproductive potential for the next generation of *Cyclops* which will be the dominant prey for juvenile salmon in the spring, two years later. Although the dependence of juvenile sockeye salmon on spring *Cyclops* abundance is strongly supported by the data, the effect on reproduction is not as strong, primarily because of spatial aggregation of *Cyclops* cohorts in midsummer to fall. Many of the early years of sampling lacked sufficient spatial resolution to quantitatively estimate cohort strength in July through September. Maintaining a spatially robust sampling scheme should resolve this issue. In addition, the monitoring of the 1996 and 1997 adult return and the copepod response to the escapements and fall fry recruitment should provide further tests to the determine the validity of the recruitment model established in 1995 (Schmidt and Tarbox 1996). This new understanding allows us to focus on two alternative explanations for variations in copepod recruitment:

1) Cropping of copepods by juvenile sockeye salmon decreases reproductive capacity and reduces subsequent copepod recruitment.

2) Copepod cohort strength is determined by abiotic factors that are independent of copepod parent brood year strength (and juvenile sockeye salmon predation).

Copepods life history is substantially different from the cladocerans, the primary sockeye salmon forage in clear water lakes. Other investigators have not only observed accentuated DVM in response to predation, but also reductions in fecundity and even initiation of diapause. Life cycles are measured in years, rather than the weeks observed with cladocerans and the small number of eggs produced per female per year (5-40) make these populations particularly vulnerable to extirpation unless predator avoidance is managed (Reviewed in Schmidt et al 1994). The 1995 studies determined the importance of seasonal availability of prey in the recruitment of juvenile sockeye salmon in the Kenai River lakes. The response of the adult population to fall fry abundance is also quite strong but the 1997 return from the very strong 1992 year class should help establish the form of this relationship. The relative constancy of the Tustumena smolt sizes provides a reasonable reference point for variations in marine survival.

The 1996 and 1997 adult returns will help clearly define if fall fry to adult returns are best estimated by a linear relationship or if the changes in abundance support compensation or depensation. These data, when coupled with a fry production model, will be useful in providing

a predictive model of stock-recruitment responses to alternative escapement scenarios. These revelations have allowed a reduction in effort and a scaling back of the program for FY97 and focus on the development of a production model for the Kenai River lakes and to determine if density dependent effects can reduce *Cyclops* recruitment. A final report will be issued for the Kodiak Island Lakes including completion of data analysis continued through 1996 field season. A proposal specifically addressing Akalura Lake will be submitted separately in attempt to restore this population which is not recovering.

A. Objectives

1. Estimate critical biological attributes (number, age, size) of both resident and migrant juvenile sockeye in over-escaped and normal escaped sockeye salmon nursery lakes of the Kenai Peninsula and Kodiak Island.

2. Determine effects on smolt production and subsequent adult returns caused by large escapements resulting from fishery closures after the EVOS. These effects will be inferred by studying the changes in the rearing capacity of selected nursery lakes which were either affected or unaffected by the oil spill. Data used for these inferences include:

    a. age and growth of juveniles and smolts
    b. nursery area nutrient budgets and plankton populations.
    c. spatial, seasonal, diel, and vertical distribution of zooplankton species and age cohorts which are the known prey of sockeye salmon in Skilak,Kenai, and Tustumena Lake;
    d. seasonally available zooplankton biomass in these lakes and the relationship of this biomass to ambient temperature, light, and other climatic variables.

3. Develop a production model for the Kenai River sockeye salmon that accounts for the trophic interactions established between copepods and rearing juvenile sockeye salmon. A key feature of this model will be to determine if copepod recruitment can be demonstrated to be related to sockeye escapements and juvenile recruitment.

B. Methods

From the inception, these investigations have used an ecosystem approach to determine factors limiting the recovery of the affected sockeye salmon population. The recent book "The Trophic Cascade in Lakes" (Carpenter and Kitchell, 1993) defines the basic approaches used by our team of investigators. These investigations also have their primary origin from other Alaskan based investigations on systems having very large escapements of fry densities (Kyle et al. 1988).

The total number of juvenile sockeye in the Kenai Peninsula glacial lakes will be estimated through hydroacoustic surveys conducted during all years up until recovery of the system is observed. This is anticipated to be demonstrated through adult returns in 1997. Age and size

information will be obtained from samples of juvenile sockeye collected from concurrent mid-water trawl netting surveys. Survey transect designs for hydroacoustic sampling and tow-netting have been established for Kenai and Skilak lakes (Tarbox and King 1989) and Tustumena Lake (Kyle 1992). Depending on densities of rearing juvenile sockeye salmon, estimates of fish densities will be made for each transect either by echo integration or by echo counting. Total fish population estimates will be computed, by summing transect populations, along with 95% confidence intervals (Kyle 1989). The number of smolt produced from Skilak lake will be inferred by conducting a spring hydroacoustic survey coupled with tow netting in 1997. This will be used to estimate overwintering mortality and will provide and index of smolt production from the lake when combined with the September, 1996 fall hydroacoustic survey. In the two Kenai Peninsula lakes, early spring and late fall sampling of fry will be conducted.

Limnological data will be collected to monitor the response of the lakes to juvenile rearing densities. Approximately six limnology surveys will be conducted at five stations on Skilak and Tustumena lakes only. Methods for limnological studies are detailed in Koenings et al. (1987). The spatial location of the sampling stations will be revised pending evaluation of existing data on July through September spatial distribution of age-0 and age-1 cohorts. These data will be used in the evaluation of the effects of juvenile salmon cropping of *Cyclops* on subsequent recruitment.

In cases where seasonal data are available (i.e. Kenai and Skilak lakes), limnological parameters taken during residence of the juveniles from the 1989 spawning escapements will be compared to parameters within these systems during prior years.

The holistic approach proposed here involves several evaluation procedures to assess the effects of sockeye salmon overescapement. On the Kenai Peninsula, we intend to develop a sockeye salmon production model which incorporates the zooplankton - juvenile salmon response relationship. Some of these analyses have been completed (Schmidt and Tarbox, 1995).

Consult Schmidt and Tarbox (1996) for further discussion of analyses and methods used to date in progress reports on these investigations.

We have also added an additional budget for permanent staff time to complete a peer published manuscript of the findings initially reported in Schmidt and Tarbox (1996). Normal agency constraints on staff require this funding to allow junior staff to backfill time to provide adequate effort to complete manuscript preparation. In addition, funding has been identified for presentation of the results at the 1997 meeting of the parent American Fisheries Society or the annual meeting of Limnology and Oceanography.

Studies on Kodiak Island will be terminated as part of this project in 1996. The Akalura Lake restoration program will be submitted as a separate proposal

C. Cooperating Agencies, Contracts and Other Agency Assistance

Administrative support is provided by the Administrative Division, Habitat Division, and Commercial Fisheries Management and Development Division staff of the Alaska Department of

Fish and Game. The project leaders and their assistants are not funded by this project and are supported with general funds from the State of Alaska. Most laboratory analyses are conducted by the limnology laboratory in Soldotna. These studies are integrated with ongoing studies by the Commercial Fisheries Management and Development Division on Kodiak Island and the Kenai Peninsula. These studies have different objectives, i.e. to manage, enhance, and rehabilitate common property salmon fisheries, but use the same techniques and data collection methods. Consequently the EVOS investigations have been integrated into the normal operations of these Divisions for efficiency in completing the objectives of these studies and the general mission of these agencies. All permits and activities on the Kenai National Wildlife Refuge are obtained and efforts coordinated through the US Fish and Wildlife Service. No external contracting with the University of Alaska.

SCHEDULE

A. Measurable Project Tasks for FFY 97

January 22-25,1997	Attend Annual Restoration Workshop
April 15, 1997	Complete draft final report for Kodiak Island:
April 15, 1997	Complete draft annual report Kenai Peninsula
September 15, 1997	Complete final report:
February 1, 1997	Submit peer manuscript

B. Project Milestones and Endpoints

The following objectives have been partially completed in reports issued to date. Adult returns in 1996 and 1997 are required to estimate juvenile - adult relationship for production model.

a. Estimate critical biological attributes (number, age, size) of both resident and migrant juvenile sockeye in over-escaped and normal escaped sockeye salmon nursery lakes of the Kenai Peninsula and Kodiak Island.

Completion on Kodiak Island	June 1, 1997
Completion on Kenai Peninsula	June 1, 1999

b. Determine effects on smolt production and subsequent adult returns caused by large escapements resulting from fishery closures after the EVOS. These effects will be inferred by studying the changes in the rearing capacity of selected nursery lakes which were either affected or unaffected by the oil spill. Data used for these inferences include:

1. age and growth of juveniles and smolts

2. nursery area nutrient budgets and plankton populations.
3. Seasonal, spatial, and diel vertical distribution of zooplankton species and age cohorts which are the known prey of sockeye salmon in Skilak, Kenai, and Tustumena Lake; and
4. seasonally available zooplankton biomass in these lakes and the relationship of this biomass to ambient temperature, light, and other climatic variables.

Completion	Kodiak Island	April 15, 1997
Completion	Kenai Peninsula	April 15, 1999

c. Develop a production model for the Kenai River sockeye salmon that accounts for the trophic interactions established between copepods and rearing juvenile sockeye salmon. A key feature of this model will be to determine if copepod recruitment can be demonstrated to be related to sockeye escapements and juvenile recruitment.

Annual Progress Report		April 15, 1997;
Submit Peer Publication		February 1, 1997
Completion	Kenai Peninsula	April 15, 1999

See supplemental study proposals for Akalura Lake.

PUBLICATIONS AND REPORTS

An annual status report detailing project results for the Kenai Peninsula will be prepared for peer review on April 15, 1997. A final separate report, detailing the results of Kodiak Island studies will be issued on April 15, 1997. A peer-reviewed manuscript will be submitted to a scientific journal by February 1, 1997. A final report on the Kenai Peninsula investigations will be submitted on April 15, 1999. We anticipate additional peer publications based on these studies.

PROFESSIONAL CONFERENCES

We have requested funding for presenting the results of these investigations at the Annual meeting of the American Fisheries Society in Monterey, California during the late summer of 1997. In addition, Dr. Dana Schmidt, is currently president of the Alaska Chapter of AFS and will be representing the Alaska Chapter and can provide additional assistance in broader scientific exposure to fisheries studies sponsored by the Trustees.

NORMAL AGENCY MANAGEMENT

The Alaska Department of Fish and Game has ongoing commercial fisheries research operations on the Kenai and Kasilof River, Frazer Lake, Red River, Akalura Lake, Upper Station Lake, and Afognak Lake. In addition, the Division has ongoing data collection activities from Hidden, Karluk, and Spiridon lakes relating to the limnology of these systems. These data are integrated

into statewide or regional data bases that are use to directly assess the impacts of the oil spill or are used as controls to measure the response of the studies proposed in this plan, against. In addition, the area research and management biologists for the Division of Commercial Fisheries management and development and numerous administrative and support staff are supported by general funds provided by the Alaska legislature. To date, most of the data analysis and reporting for the sockeye salmon over-escapement project has been provided for from contributions of the State of Alaska from these general funds. Total funding for these programs exceeds $1 million. Major funding cuts are anticipated to the Limnology program this upcoming year. In anticipation of these cuts, we have provided some funding for PFT positions to insure we have adequate time for preparation of peer publications.

The investigations of Kodiak and Kenai River sockeye salmon have been integrated with long term research efforts by the Alaska Department of Fish and Game on these stocks. In addition, studies by the limnology laboratory and the fisheries development staff on Kodiak Island on these systems are included in data analysis. Study design and methodology builds off of earlier efforts. Planning and permitting of research activities and future rehabilitation efforts are coordinated through the USFWS Refuge staff in Soldotna and on Kodiak Island. None of the studies funded either have been in the past or are anticipated in the future to be funded as a part of normal Departmental operations.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The studies proposed provide for data collection and field sampling programs. As such no environmental effect of these programs occurs beyond that of traditional fisheries management data collection activities and is within existing collecting permits or Federal special use permits issued to the Department of Fish and Game for scientific data collection activities. New programs on the National Wildlife Refuge are updated through permit amendments as needed. No other permits or other coordination activities are involved.

Several other proposals will be submitted that complement or in part, based on the data established by this project.

Dr. Bruce Finney will be submitting a proposal to examine the longer term response of lakes within the spill area, to period pre-and post fishery. This program will complement work conducted by NRC in 1996. Dr. Finney's study will provide a much broader time line (greater than 50 years) and therefore put the EVOS overescapement theory to a broader historical test.

The Kodiak office of commercial fisheries management and development will be submitting a proposal to develop an environmental assessment of back-planting fry into Akalura Lake. This system remains in very poor condition. This should be a high priority.

A study is also being submitted that looks at secondary impacts of sockeye salmon escapements on the Kenai River. Although adult sockeye salmon carcass effects on lake productivity have not been demonstrated to be highly significant (through delta N15 analysis of smolt and limited sampling of the sediment) these carcasses may have a pronounced effect on the production of lower and middle Kenai River rearing chinook salmon. The development of a holistic

perspective of salmon escapements, using a multiple species approach, can help define the importance a strong sockeye salmon population in the Kenai River system. Although other species occur in this system, chinook juveniles are highly dependent upon food resources in river. Development of stable isotope analyses through the food chain have provided the tools necessary to determine the relative importance of salmon carcasses to the productivity of this system.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

The proposed studies terminate the field work on Kodiak Island with the exception of the Akalura restoration project, submitted separately. These changes follow recommendations of the reviewers. We have added an additional objective which concentrates on improving the production model we are developing for the Kenai River sockeye salmon. By establishing if there are significant effects on zooplankton recruitment through over-cropping, we can determine if a top-down response to large escapements are observed for a single year beyond the escapement or if a three year lag in the response of the zooplankton recruitment is observed in the juvenile sockeye salmon recruitment. Spatial resolution of cohorts is needed to have adequate data to test this hypothesis. The additional year's monitoring of zooplankton with improved spatial resolution should provide the needed resolution to resolve this question. These data, when coupled with the adult returns of 1996 and 1997 should fill in the missing parts of our sockeye salmon production model on this system.

PROPOSED PRINCIPAL INVESTIGATOR

Dana Charles Schmidt
Alaska Department of Fish and Game
Commercial Fisheries Management and Development Division
34828 Kalifornsky Beach Rd, Suite B
Soldotna, Alaska 99669
FAX (907) -262-7646
(907)262-9368

PERSONNEL

Dana Charles Schmidt
Alaska Department of Fish and Game
Commercial Fisheries Management and Development Division
34828 Kalifornsky Beach Rd, Suite B
Soldotna, Alaska 99669

EMPLOYMENT:

October, 1991 to Present. Limnologist III, Principal Limnologist, FRED Division, Alaska Department of Fish and Game, Soldotna, AK. Responsibilities include establishing research objectives for the Statewide limnological investigations of the Commercial Fisheries Management and Development Division. This section provides direction for other components of the Division for determination of stocking rates for sockeye salmon in lakes and in the application of fertilization. This section also provides input to the commercial fisheries division for determination of the escapement goals for sockeye salmon. Supervise the limnology laboratory which completes water quality and plankton analysis for water samples taken from several hundred lakes statewide.

April, 1985 to October, 1991: Fishery Biologist IV, Regional Research Biologist, Westward Region, Alaska Department of Fish and Game. Responsible for establishing research objectives and priorities for the Westward Region Commercial Fisheries Division. This Division has management authority over extensive salmon and herring stocks on the Alaska Peninsula and Kodiak Island, in addition to management of the major shellfish stocks in the Gulf of Alaska and the Bering Sea. Annual ex-vessel value of these fisheries is several hundred million dollars, Research highlights included studies of crab larvae settling rates in the Gulf of Alaska and investigations on the effects of oil spill overescapement on the sockeye salmon production of major lakes on Kodiak Island.

May, 1982 to September, 1985: Acting F.B. IV, Susitna River Aquatic Studies Coordinator, Alaska Department of Fish and Game. The entire program under supervision included approximately 25 permanent and 50 seasonal employees. During this interim period, responsible for reorganizing the studies into a more efficient structure to meet the long term monitoring needs for determination of the effects of the Susitna project on the aquatic resources of the Susitna River. Supervised development of operational plans for 18 technical study programs on the Susitna River, assignment of priorities of tasks, and review of the technical merit of the programs proposed. Prior to January 1985. F.B. III, Resident and Juvenile Anadromous Project Leader, Su-Hydro Aquatic Studies Program, Alaska Department of Fish and Game. Supervised research programs on resident and juvenile anadromous fish in the Susitna River that may be impacted by development of the Su-Hydro Project. Technical studies included development of models of sport fishery exploitation on arctic grayling populations, modeling instream flow responses of juvenile salmon habitat, development of baseline population parameters of resident fish and juvenile salmon and development of

projections of supersaturated gas dissipation below the proposed dam sites.

January, 1981 to May, 1982: Fishery Biologist, Terrestrial Environmental Services, Anchorage, Alaska. Responsible for field and office review of the aquatic studies programs of the Alaska Power Authority for the Susitna Hydro-Electric Program. This responsibility included assisting the Alaska Department of Fish and Game in study plan development, providing preliminary assessment of impacts of the project on aquatic resources and presenting to the public progress of the aquatic studies programs.

May, 1980 to October 1980: Fishery Biologist, U.S. Fish and Wildlife Service, Soldotna, Alaska. Assisted on a radio-telemetry project and juvenile salmon habitat survey on the Kenai River, 6-mile Creek and the Deshka River in the Cook Inlet area. Activities included tagging and radio tagging chinook and coho salmon, collection of juvenile salmon and measurements of associated habitat, and assisting in the analysis of scale patterns from Kenai River chinook salmon. Other activities included statistical analysis of data, report review and preparation of a publication on the Kenai River chinook for Alaska magazine.

EDUCATION:

Ph.D. in Fisheries 1973
Major Field - Fisheries- Minor Field Pharmacology,
Oregon State University, Corvallis, Oregon
M.S. in Biology, 1970 Major Field - Aquatic Biology Minor Field - Sanitary Biology,
University of Utah, Salt Lake City, Utah
B.S. in Wildlife Biology, 1968, University of Montana, Missoula, Montana

Ken Tarbox
Alaska Department of Fish and Game
Commercial Fisheries Management and Development Division
34828 Kalifornsky Beach Rd, Suite B
Soldotna, Alaska 99669

EMPLOYMENT:

May, 1980 to Present. UCI Research Project Leader, Alaska Department of Fish and Game, Soldotna, Alaska. Responsibilities include planning, implementing, supervision, and reporting on various salmon related research and management projects. These involve hydroacoustic enumeration of salmon in glacial systems, defining salmon migratory behavior in both salt and fresh water, evaluation of potential impacts of resource development on habitat and populations, management of the UCI commercial salmon fisheries, stock identification studies using scale or genetic markers, and life history studies of sockeye salmon.

March, 1972 to May, 1980. Project manager and Senior Biologist, Woodward Clyde Consultants, Anchorage, Alaska. Responsibilities included supervision and research for

a number of projects. These included an evaluation of existing methodologies for determining instream flow requirements for Alaskan fishes, determining the biological impact of a dredging projects located in lower New York Harbor and Lake Michigan, fishery investigations in the Zayandeh River, Iran, impact assessment of various oil related projects in Virginia, North Carolina, Texas, and Prudhoe Bay, Alaska, and studies and evaluation of impacts associated with nuclear power plants in New Jersey, Louisiana, Indiana, and Pennsylvania.

July, 1970 to March, 1972. Research Assistant, Louisiana Co-operative Fishery Unit, Louisiana State University, Baton Rouge, La. Responsibilities included the design and conduct of a one year investigation of juvenile fish behavior in an estuarine environment.

EDUCATION:

M.S. in Fisheries, 1974. Louisiana State University, Baton Rouge, La.
B.S. in Fisheries Science. 1970. University of Washington, Seattle, Wa.

CERTIFICATIONS:

Fisheries Scientist, Certificate 1165, American Fisheries Society, 1976.

Stan R. Carlson
Alaska Department of Fish and Game
Commercial Fisheries Management and Development Division
34828 Kalifornsky Beach Rd, Suite B
Soldotna, Alaska 99669

EMPLOYMENT:

January 1993 - present: Biometrician for the Alaska Department of Fish and Game, Limnology Section, Commercial Fisheries Management and Develop Division, Soldotna, Alaska. Supervised by Dr. Dana Schmidt. Conduct statistical data analyses to evaluate factors that affect dynamics of the biota in lake ecosystems. Design limnological experiments and determine methods to estimate zooplankton and salmon abundance. Develop and approve methods to estimate hatchery contributions to the fishery. Develop, review, and conduct statistical analyses for projects related to the impact of oil on commercial fishery species. Provide biometrical consulting to area and regional biologists and statewide limnologists.

November 1991 - January 1993: Mathematical Statistician for the National Marine Fisheries Service, Auke Bay Laboratory, Juneau, Alaska. Supervised by Mr. Steven Ignell. Conduct statistical studies on community attributes of pelagic fauna in the north Pacific Ocean. Provide biometrical consulting, technical editing, and collaborative input on projects such as salmon bycatch and climate change studies.

January 1989 - May 1991: Statistics Teacher, Experimental Statistics Department, New Mexico State University, Las Cruces. Supervised by Dr. Michael Ames. Instruct laboratory courses in statistics for undergraduate science majors.

May - August 1990: Research Specialist (statistician), Department of Entomology, Plant Pathology, and Weed Science, New Mexico State University. Dr. Ellis Huddleston, Supervisor. Provide statistical modeling, analysis, and design of experiments related to agricultural field studies and pest management programs.

May - December 1988: Field Biologist, Biology Department, New Mexico State University. Supervised by Mr. Roger Skaggs. Conduct field population surveys and habitat analyses of night birds in Lincoln National Forest, New Mexico. Collect field data, supervise field personnel, and maintain data records. Develop operational strategies and conduct follow-up statistical estimation procedures.

August 1985 - June 1988: Graduate Assistant, Biology Department, New Mexico State University. Supervised by Dr. Ralph Raitt and Dr. Walt Whitford. Teach undergraduate biology and zoology laboratory courses. Collect data and maintain field ecology experiments for ecological research programs. Develop and conduct original field research on desert insect ecology.

June 1983 - May 1985: Research Specialist, Gordon Environmental Studies Laboratory, University of Montana, Missoula. Supervised by Dr. Philip Tourangeau. Manage data, conduct quality assurance/control procedures, and perform statistical analyses for environmental science projects. Aid in the design and implementation of field research, primarily in the area of pollution biomonitoring.

EDUCATION:

1991 Master of Science, Experimental Statistics, New Mexico State University.
1988 Master of Science, Biology (ecology), New Mexico State University.
1983 Bachelor of Arts, Environmental Biology, University of Montana

Gary Kyle
Alaska Department of Fish and Game
Division of Commercial Fisheries Management and Development
34828 Kalifornsky Beach Road, Suite B
Soldotna, Alaska 99669

Experience:

April 1977 - April 1988: Project Biologist and later Area Biologist for the Division of Fisheries Rehabilitation, Enhancement, and Development of the ADF&G in Soldotna Alaska. Conducted and evaluated various fisheries enhancement and evaluation projects in the Cook Inlet watershed including limnological investigations of sockeye salmon producing lakes, and evaluation of hatchery stocking programs. Also, during the period

I served as a project limnologist for the Limnology Section which involved the collection, analysis, and interpretation of limnological data from sockeye nursery lakes for assessment of rearing capacity and for modeling purposes.

April 1988 - present: Regional Limnologist for the Limnology Section for ADF&G in Soldotna, Alaska. Supervised by Dr. Dana Schmidt. As the Regional Limnologist for the Southcentral Region comprising of the Interior, PWS, Cook Inlet, and Alaska Peninsula; the primary purpose of this position is the supervision of staff in the coordination, assignment, prioritization, analysis, and review of subordinates work and interagency contract work related to lake fertilization and stocking projects, water quality monitoring projects, and fisheries and limnological research. In addition, the position is responsible for training subordinates, reporting and review of project results for publications and meetings, and administrating state and non-state (contract) budgets.

Education:

1975 Bachelor of Science, Life Science/Natural Resources, University of Wisconsin.

Publications:

A total of 44 technical reports, 10 journal manuscripts, 25 formal presentations, and 6 magazine articles dealing with adult sockeye production, lake fertilization, lake stocking, and in-lake assessments of juvenile sockeye production.

LITERATURE CITED

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Koenings, J. P., and R. D. Burkett. 1987. Population characteristics of sockeye salmon (Oncorhynchus nerka)smolts relative to temperature regimes, euphotic volume, fry density, and forage base within Alaskan Lakes. p. 216-234. In H. D. Smith, L. Margolis, and C. C. Wood [ed.] Sockeye salmon (Oncorhynchus nerka) population biology and future management. Can. Spec. Publ. Fish. Aquat. Sci. 96.

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Rept No. 126.

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1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997	LONG RANGE FUNDING REQUIREMENTS					
Personnel	$582.7	$216.9						
Travel	$8.2	$5.7						
Contractual	$61.2	$18.5						
Commodities	$50.4	$15.0						
Equipment	$37.0	$0.0						
Subtotal	$739.5	$256.1	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
General Administration	$91.7	$33.8						
Project Total	$831.2	$289.9	$250.0	$250.0	$20.0	$0.0	$0.0	
Full-time Equivalents (FTE)		3.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

This revised FY97 budget submittal reflects a discontinuation of the Kodiak Island overescapement field studies. A closeout final report for Kodiak Island will be prepared the coming fall and winter. A separate proposal addressing the restoration of Akalura Lake is being submitted.
The field program for Kenai Peninsula Lakes has been reduced to develop only the data needed to examine parental effects on zooplankton recruitment and their subsequent response on juvenile recruitment success and growth. Funding has been included to provide for permanent staff salaries to prepare a peer review manuscript for journal submission, beyond normal annual reporting and final reporting requirements.

1997

Prepared:

Project Number:97258
Project Title: Sockeye Salmon overescapement
Agency: ADF&G

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1997
PCN 115041-DS	Principal Investigator-DS-Limno III	21K	1.0	7		7.4
PCN 115038-GK	Reg. Limnologist III-GK	19K	1.0	7		6.5
PCN 117030-SC	Biom II -SC	19C	8.0	6		45.8
PCN 115086-JE	Limnologist I -JE	17K	2.0	6		11.6
PCN 113587-MS	Tech III-MS	11E	2.0	4		7.2
FB I-Limnology-4 positions	Lab staff-Report writing & field collection	14J	12.0	5		55.5
Tech III-Limnology-3 position	Lab staff-Report Writing	11E	3.0	4		10.8
FBI-Kenai CFMD-3 positions	FBI data analysis and field data collection	14E	6.0	4		25.5
Tech III-Kenai CFMD-1 positi	Tech III data analysis & field data collection	11J	3.0	4		11.1
Tech II-Kenai CFMD-3 positio	Tech II data analysis & field data collection	9C	2.0	3		5.8
PCN 111332 LC	FB II Kodiak Report Writing	16B	2.7	5		13.5
PCN 111721 CS	FBIII Kodiak Report Writing	18D	2.7	6		16.2
	Subtotal		45.4	59.1	0.0	
					Personnel Total	$216.9

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
Travel to and From Anchorage-workshop 1-D.Schmidt	0.12	1	5	0.1500	0.9
Travel to and From Anchorage-workshop 2-D.Schmidt	0.12	1	2	0.1500	0.4
Travel to and From Anchorage workshop 2-G.Kyle	0.12	1	2	0.1500	0.4
Travel to and From Anchorage workshop 2 S. Carlson	0.12	1	2	0.1500	0.4
Travel to and From Anchorage workshop 2 K. Tarbox	0.12	1	2	0.1500	0.4
Travel to and From Anchorage workshop 2 B. King	0.12	1	2	0.1500	0.4
Travel to and From Anchorage workshop 2 C. Swanton	0.24	1	2	0.1500	0.5
				0.1500	0.0
Scientific meeting to present results-National AFS	1.2	1	4	0.1500	1.8
Public presentations and meetings-Anchorage	0.12	2	2	0.1500	0.5
					0.0
					0.0
				Travel Total	$5.7

1997

Prepared:

Project Number: 97258
Project Title: Sockeye Salmon Overescapement
Agency: ADF&G

FORM 3B
Personnel
& Travel
DETAIL

4/12/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Contractual Costs:		Proposed
Description		FFY 1997
Rept	Long distance telephone and toll costs 10 months @ $500, copying and binding- 50 copies @ $10)	$5.5
Rept	Computer equipment repair (4 hard drives @ $500, one motherboard @ $1.0)	$3.0
Rept	Software maintenance and upgrades- SAS license, netware licenses upgrade	$2.9
Rept	Postage (10 months @ $250), photo processing (25 rolls @ $20), messenger service ($0.5)	$3.3
Rept	Conference registrations	$0.5
	Hydroacoustic equipment calibrations	$1.5
Field	Film processing and purchasing	$0.3
	Vehicle repair	$1.0
Field	Auto euip & parts	$0.5
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$18.5

Commodities Costs:		Proposed
Description		FFY 1997
Rept	Office supplies-Paper ($1.0), Xerox supplies and computer printer supplies ($1.5)	$2.5
Rept	Laboratory glassware ($1.0), chemical reagents ($1.5)	$2.5
Rept	Photographic supplies - camera parts and film	$0.5
	Stationery ($1.0) and duplicating supplies - xerox toner-supplies ($2.0)	$3.0
Field	Raingear, hip boots and gloves for 6 people @ $250	$1.5
Field	Food (100 man days @ $15/day)	$1.5
Field	Flotation coats for 2 people @ $250	$0.5
Field	First-Aid/safety supplies-Life raft repack ($1.0)	$1.0
Field	Fuel costs- all vehicles and vessels	$2.0
	Commodities Total	$15.0

1997

Prepared:

Project Number: 97258
Project Title: Sockeye Salmon Overescapement
Agency: ADF&G

FORM 3B
Contractual & Commodities DETAIL

4/12/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Optical Plankton Counter-with winch and towing body	1	ADF&G
boats, metal hull	2	ADF&G
boats, rubber	2	ADF&G
motor, outboard	5	ADF&G
acoustic sounder	1	ADF&G
oscilloscope	3	ADF&G
Innoculator, air inject	3	ADF&G
freezer	1	ADF&G
recorder, data	3	ADF&G
computer	4	ADF&G
radio/location equip	3	ADF&G

1997

Project Number: 97258
Project Title: Sockeye Salmon Overescapement
Agency: ADF&G

FORM 3B
Equipment
DETAIL

Prepared:

4/12/96