94320K

EXXON VALDEZ OIL SPILL DETAILED PROJECT DESCRIPTION

Project Title:	PWSAC - PWS System Investigation - Experimental Fry Release
Project Number:	94320
Project Type:	Research/Monitoring
Project Leader:	Jeff Olsen, PWSAC Operations Manager
Lead Agency:	Ak. Depart. of Fish and Game (ADF&G)
Cooperating Agency:	None
Other Cooperating Parties:	Prince William Sound Aqua. Corp. (PWSAC) University of Alaska Fairbanks (UAF) PWS Science Center (PWSSC)
Cost of Project, FY94:	$45,000
Project Startup Date:	March 1, 1994
Project Completion Date:	June 30, 1994
Geographic Area:	Prince William Sound
Project Leader:	Jeff Olsen, PWSAC Operations Manager
Project Manager:	Joe Sullivan, ADF&G Resource Prog. Mgr.

INTRODUCTION

Pink salmon hatcheries operated by the Prince William Sound Aquaculture Corporation annually release approximately 400 million pink salmon fry from three hatcheries located in the northern, northwestern, and southwestern corners of Prince William Sound. The fact that release timing, release location, size at release and number released per day can be controlled makes the hatchery pink salmon attractive as an experimental tool. The Sound Ecosystem Assessment (SEA) program advocates that experimental releases of hatchery juveniles will provide a powerful test of the influence of ocean-entry timing and of fry size at ocean entry on losses to predators. This notion is further supported by Dr. George Rose who wrote "experimental management can be done at Prince William Sound hatcheries in collaboration with the SEA research proposal".

SEA focuses on processes and mechanisms that regulate losses of fry and juveniles to predators after emergence from nearshore natal habitats. Previous studies in Alaska and elsewhere suggest that fry size is an important determinant of survival during early marine residence. Faster growing juveniles are thought to enjoy better marine survivals than slower growing fish. Preliminary evidence from

Prince William Sound indicates that fry growth rate is often a good predictor of adult survival.

Current release strategies for PWSAC hatchery pink salmon include the following three groups:

"Early Fed Fry": These fry are held in saltwater rearing pens and fed for 10-20 days prior to release at the peak of the nearshore macro-zooplankton bloom. This group typically comprises 80%-90% of the total release. The average size at release is generally between 0.25 grams and 0.35 grams

"Direct Release": These fry are held in saltwater rearing pens for no more than 3 days and released because their outmigration timing corresponds with the macro-zooplankton bloom. This group typically comprises 5%-10% of the release. The average size at release is generally 0.23 grams.

"Late Fed Fry": These fry outmigrate after the macro-zooplankton bloom and are held in saltwater rearing pens until late May/early June. This group typically comprises 5%-10% of the release. The average size at release is generally between 0.30 grams and 0.35 grams.

A portion of all fry from each group are coded wire tagged making comparisons of the various strategies possible. In general the "early fed fry" have outperformed the other two groups in terms of fry to adult survival. Preliminary results from fry recapture studies using tagged hatchery pink salmon suggest that fry entering the ocean at the time of the macro-zooplankton bloom show a size advantage by mid June to early July apparently because of their longer exposure to natural food sources. This size advantage is modified by temperature and is correlated to better overall marine survival. To further assess the influence of size at ocean entry and time of ocean entry on survival of PWS pink salmon, a fourth rearing strategy is proposed for hatchery pink salmon. Approximately 16 million pink salmon fry at two hatcheries will be reared to 1.5 grams for a late spring release in 1994.

Finally, the project described here is an integral component of the ecosystem based research called the Prince William Sound Sysytem Investigation. This amalgamation of research projects includes the SEA progam studies. The ADF&G is the lead agency on the Prince William Sound System Investigation and several of the other Trustee agencies are acting in a cooperating capacity.

PROJECT DESCRIPTION

1. Resources and/or Associated Services:

This project is a critical component in research and restoration of PWS pink salmon because it will allow control of key variables that are thought to effect early marine growth rate and mortality. In addition, pink salmon are thought to play an important role in the survival of other fishes, birds and mammals. This project will help identify those other species and the importance of pink salmon to each.

2. Relation to Other Damage Assessment/Restoration Work:

This project is part of the SEA program research planned for 1994. Further, "experimental release" of PWS hatchery pink salmon have been identified as a necessary component of any ecosystem based research in PWS. The pink salmon release strategy defined in this proposal will complement the three strategies currently used by PWSAC which are described in a separate project description. Together, the experimental release and experimental manipulation projects complement the planned juvenile salmon growth and predator projects. All are critical components of the SEA project necessary to support or refute the program hypotheses regarding the PWS ecosystem.

3. Objectives:

The goal of this project is, through collaboration with the SEA program, to assist "to develop an ecosystem level understanding of the natural and man-caused factors influencing the production of pink salmon...in PWS". Specific objectives are:

A. Rear 8 million early emerging fry each at the Wally Noerenberg hatchery (WNH) on Esther Island and Armin F. Koernig hatchery (AFK) on Evans Island to 1.5 gram live weight for release in mid-June.

B. Determine the marine survivals of fry in experimental releases from coded wire-tagged individuals recovered in the brood stocks and common property fishery the following year.

C. Compare the marine survivals of late released larger fry with other releases (see "experimental manipulation" project description) at these same hatcheries.

4. Methods:

AFK and WNH hatchery pink salmon fry begin exiting the incubators volitionally at an average weight of 0.23 grams in mid March and are carried, via gravity flow, through plastic plumbing and a bank of electronic fry counters. Following enumeration, the pink fry are conveyed via flex hose to 12m X 12m X 3m (450m3) saltwater rearing pens. Approximately 8 million fry will be loaded in two rearing pens of 4 million each at the two hatchery locations. Pen loading should be complete by late March.

During pen loading, 1/2mm Coded Wire Tags (CWT) will be applied to approximately 1 out of every 200 fry in the experimental groups. Each pen of fry will contain a unique code. The CWT fry are integral to tracking migration patterns of pink fry, and estimating fry growth and mortality.

All fry will be fed a standard commercial diet of soft semi-moist fish food during the 75-85 days prior to release. Releases will occur simultaneously at the two facilities on or about June 15 when the fry are expected to have attained an average live weight of 1.5 grams. Routine reports on the rearing status of the fry as well as final release information will be communicated to SEA biologists on

board trawl and purse seine vessels to assure nearshore and open water sampling is targeted on released fry.

5. Location:

This project will take place in PWS at the Armin F Koernig hatchery on Evans Island, and the Wally Noerenberg hatchery on Esther Island.

6. Technical support:

The PWSAC salmon program receives technical support from permitting agencies, University of Alaska Fairbanks, University of Alaska Juneau, and PWS Science Center. The ADF&G pathology lab, genetics lab, and coded wire tag lab are among specific expertise areas overseeing the hatchery salmon program. ADEC provides technical support on terrestial and tidelands concerns. The Cordova ADF&G staff are in constant communication with PWSAC staff to monitor marine conditions and provide technical guidance in hatchery practices.

7. Contracts:

PWSAC contracts barge services for transporting bulk supplies and personnel to each hatchery.

SCHEDULE

The project activities are as follows:

Feb 1994-Apr 1994:	Oversee development of incubating pink salmon eggs and perform routine eggcare and incubation environment monitoring.
Mar 1994-Jun 1994:	Enumerate, CWT, rear and release pink salmon fry.
Apr 1994-Jun 1994:	Coordinate/communicate rearing and release of hatchery pink salmon fry with SEA research team.

Operations at each hatchery are coordinated by a hatchery manager. Each hatchery manager is responsible for meeting the incubation, rearing and release goals at his/her facility. During the fry release cycle, the hatchery managers will be responsible for communicating release plans and detailed information to the SEA biologist coordinating the pink salmon fry studies. The operations manager is responsible for overseeing the operations at all hatcheries and coordinating involvement in the PWS ecosystem study. The hatchery managers report to the operations manager.

EXISTING AGENCY PROGRAM

PWSAC operates four salmon hatcheries in PWS and one on the Copper River system. Five species of salmon are produced between the five facilities. The total annual operating budget including administrative services and capital and major maintenance replacement for these facilities is approximately $8.0 million.

ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS

Permiting is a significant aspect of the PWSAC salmon program. Hatcheries must receive extensive permitting prior to construction which address water use and quality, land use, wild stocks and other concerns. Each salmon project must receive ADF&G review and permitting with scrutiny for genetic and disease histories, wild stock interactions, fishery management implications and common property benefit. Hatchery sites also require permitting from Department of Army Corp, DNR Lands Division, Forest Service special use or EA permitting if necessary, and ADF&G fish transport permits.

PERFORMANCE MONITORING

Monthly hatchery reports prepared by each PWSAC hatchery manager are forwarded to the operations manager and president. These reports detail on-going results of each production cycle relative to established goals for PWSAC hatchery pink salmon. The parameters measured include total eggs taken, number of eggs surviving to the eyed stage of development, number of fry surviving to emergence, number of fry surviving to release, number of fry released by treatment group, number of fry tagged by treatment group. A summary of pink salmon fry releases by hatchery, day released and tag code will be prepared for inclusion in the SEA program progress reports. All pink salmon incubation and release data will be summarized in an annual report required of all hatchery operators by the ADF&G.

The PWSAC operations manager and production manager travel to all hatcheries for quarterly production reviews to support hatchery staff through review of quality standards and production goals. Production schedules such as planned hatchery releases and procedures are defined in advance of each production cycle. The PWSAC management team and SEA researchers will plan and coordinate the pink salmon fry release schedule to assure the goals of the SEA program are met (as described under Coordination of Integrated Research Effort below).

In addition to monthly reports and annual reports, all CWT data is summarized on D-Base database software provided by the ADF&G. ADF&G quality control standards will be followed throughout tag application and reporting.

A report will be provided to the EVOS Trustees describing the results of the 1994 hatchery pink salmon fry release program.

COORDINATION OF INTEGRATED RESEARCH EFFORT

This project is part of the SEA ecosystem research studies which will be undertaken in FY94 (project 94320). In particular, those studies looking at salmon growth, salmon predators and prey, primary and secondary production, avian predation and nearshore fish aggregations are collaborating with the hatchery operator to describe pink salmon fry rearing and release plans and establish the protocol for in-season communication and coordination of results in the field.

The funding described for this project is necessary for the production and release of 1.5 gram coded wire tagged hatchery pink salmon. Because the approved SEA proposal is the first integrated ecosystem study of its kind in PWS, SEA researchers, in consultation with the hatchery operator, recommend the hatchery release strategies employed in 1994 emulate those used in the past by PWSAC with the exception of this proposed release group.

PUBLIC PROCESS

Alaska state law requires that PWSAC, as the regional aquaculture corporation in PWS, be comprised of representatives of all interested user groups and possess a board of directors "which includes no less than one representative of each user group that belongs to the association". The concept of a regional association is intended to allow active public participation in the salmon rehabilitation program. The PWSAC board of directors is comprised of: commercial / sport / subsistence / personal use fishermen, native representatives from villages in PWS and the Copper River region, representatives of the fish processing industry and representatives of the communities in PWS.

At their September 1993 meeting, the board of directors endorsed PWSAC's participation in the ecosystem planning effort that had just begun and supported PWSAC's involvement in the PWSFERPG. The board gave high priority to research objectives that addressed the current decline in the PWS pink salmon runs and emphasized the need to include hatchery pink salmon fry releases as part of the larger ecosystem study being developed by PWSFERPG.

PWSAC, other members of the PWSFERPG, and the public participated in a workshop in December, 1993 at which the SEA ecosystem plan was endorsed as innovative, reasonable and scientifically testable by a group of independent scientists and agents of the EVOS Trustee council. The SEA plan identifies the hatchery releases of pink salmon fry as important to develop an ecosystem level understanding of the natural and man-caused factors influencing the production of pink salmon.

PERSONNEL QUALIFICATIONS

Jeffrey B. Olsen

Work Experience

1989-Date: Operations manager for PWSAC. Oversee operations of five salmon hatcheries producing five species of Pacific salmon. Work with the PWSAC and regional planning groups to develop fish production goals. Responsible for achievement of hatchery production objectives. Work with the ADF&G and other state and federal agencies to assure the PWSAC enhancement program is in compliance with regulation and required permits. Work with hatchery staff, fish culture industry, ADF&G, and scientific community to develop research goals for enhancement program. Oversee the budgets of five hatcheries totaling over $4.0 million.

1988-1989: WNH hatchery manager, PWSAC. Oversee operations of PWSAC's largest salmon hatchery. Responsible for production of four species of Pacific salmon.

1986-1988: WNH hatchery assistant manager, PWSAC.

1982-1986: AFK hatchery fish culturist and assistant manager, PWSAC.

Education

1977-1981: Univ. of Washington., B.S. Degree in Fisheries Science

BUDGET (attached)

EXXON VALDEZ TRUSTEE COUNCIL
1994 Federal Fiscal Year Project Budget
October 1, 1993 - September 30, 1994

Project Description: PWSAC - PWS System investigation - Experimental Release. This project is part of the SEA ecosystem study. Approximately 16,000,000 pink salmon fry at two hatcheries will be reared to 1.5 grams for a late spring release in 1994 to measure the influence of size at ocean-entry and time of ocean-entry on growth and mortality.

Budget catagory	1993 Project No. Authorized FFY 93	93 Report/ 94 Interim* FFY 94	Remaining Cost** FFY 94	Total FFY 94	FFY 95	Comments
Personnel	$0.0	$0.0	$1.0	$1.0		
Travel	$0.0	$0.0	$0.0	$0.0		
Contractual	$0.0	$0.0	$0.0	$0.0		
Commodities	$0.0	$0.0	$40.0	$40.0		
Equipment	$0.0	$0.0	$4.0	$4.0		
Capital Outlay	$0.0	$0.0	$0.0	$0.0		
Subtotal	$0.0	$0.0	$45.0	$45.0	$0.0	
General Administration	$0.0	$0.0	$0.0	$0.0	$0.0	
Project Total	$0.0	$0.0	$45.0	$45.0	$0.0	
Full-time Equiv. (FTE)	0.0	0.0	0.1	0.1	0.0	

Dollar amounts are shown in thousands of dollars

Budget Year Proposed Personnel: Position Description	Reprt/Intrm Months	Reprt/Intrm Cost	Remaining Months	Remaining Cost
Wages - temporary 100 manhours @ $10/hour (apply coded wire tags, feed pink salmon)			5.0	$1.0
Personnel Total	0.0	$0.0	5.0	$1.0

NEPA Cost: $0.0

* Oct 1, 1993 - Jan 31, 1994
** Feb 1, 1994 - Sep 30, 1994

Project Number: 94320
Project Title: PWSAC - PWS Sys. Inv. - Exp. Release
Agency: Prince William Sound Aquaculture Corporation

EXXON VALDEZ TRUSTEE COUNCIL
1994 Federal Fiscal Year Project Budget
October 1, 1993 - September 30, 1994

	Rept/Intrm	Remaining
Travel:		
	$0.0	$0.0
Travel Total	$0.0	$0.0
Contractual		
	$0.0	$0.0
Contractual Total	$0.0	$0.0

Project Number: 94320
Project Title: PWSAC - PWS Sys. Inv. - Exp. Release
Agency: Prince William Sound Aquaculture Corporation

EXXON VALDEZ TRUSTEE COUNCIL
1994 Federal Fiscal Year Project Budget
October 1, 1993 - September 30, 1994

Commodities:	Rept/Intrm	Remaining
Fish food - 25,300 kg @ $1.58/kg	$0.0	$40.0
Commodities Total	$0.0	$40.0
Equipment:		
Coded wire tags - 80,000 @ $0.05/tag	$0.0	$4.0
Equipment Total	$0.0	$4.0

Project Number: 94320
Project Title: PWSAC - PWS Sys. Inv. - Exp. Release
Agency: Prince William Sound Aquaculture Corporation

EXXON VALDEZ OIL SPILL DETAILED PROJECT DESCRIPTION

Project Title:	PWSAC - PWS System Investigation - Experimental Manipulation
Project Number:	94320
Project Type:	Research/Monitoring
Project Leader:	John McMullen, PWSAC President
Lead Agency:	Ak. Depart. of Fish and Game (ADF&G)
Cooperating Agency:	None
Other Cooperating Parties:	Prince William Sound Aqua. Corp. (PWSAC) University of Alaska Fairbanks (UAF) PWS Science Center (PWSSC)
Cost of Project, FY94:	$1,750,000
Project Startup Date:	February 1, 1994
Project Completion Date:	June 30, 1994
Geographic Area:	Prince William Sound
Project Leader:	John McMullen, PWSAC President
Project Manager:	Joe Sullivan, ADF&G Resource Prog. Mgr.

INTRODUCTION

During the 1980's commercial catches of pink salmon in Prince William Sound (PWS) reached record highs as a result of record wild stock returns and increasing production of hatchery pink salmon. However, in 1991, an aberrant return of adult pink salmon, spawned in the parent year of 1989 (the year of the Exxon Valdez oil spill), came in late and Dark and millions went unsold. In 1992, the wild and hatchery pink salmon return was approximately one-third of the projected size; in 1993, pinks came back at about one-fifth of their expected strength.

These failed pink salmon returns to Prince William Sound, coupled with deflated fish prices, resulted in financial disaster for commercial fisherman and for the Prince William Sound Aquaculture Corporation (PWSAC). In an effort to understand the ecosystem of the Sound and determine the causes of the pink salmon run failures, the fisherman, PWSAC and ADF&G joined in a bioregional PWSAC - PWS System Investigation - Experimental Manipulation coalition - Prince William Sound Fisheries Ecosystem Research Planning Group

(PWSFERPG) - encouraged and funded by the Exxon Valdez Oil Spill (EVOS) Trustee council. PWSFERPG also consists of local scientists, communities, resource managers and other resource users of the Sound.

The task undertaken by the PWSFERPG was to develop a research plan for the Sound, using an ecosystem approach to study damaged pink salmon and herring and the principal species interacting with them. These pelagic fishes support a host of birds and mammals, some of which have also been described as injured species. The result was the Sound Ecosystem Assessment (SEA) program. The draft SEA plan was reviewed by independent scientists and agents of the EVOS Trustee council at a workshop in December 1993, and was endorsed as innovative, reasonable, and scientifically testable.

Key to rehabilitating the pink salmon of PWS is understanding the complex species interactions that occur during the critical early marine life stages. As is addressed in the SEA proposal, releases of hatchery produced pink salmon fry "will provide a powerful test of the influence of ocean-entry timing and fry size at ocean entry on losses to predators". By using hatchery pink salmon, important variables such as release timing, release location, number of fry released, fry age, and fry size can be controlled. In addition, a portion of all hatchery pink salmon fry released are marked, making assessments of early marine growth, life stage mortality and migration patterns possible at a reasonable cost.

This plan advocates the integral role of the hatchery program in the research and restoration of PWS pink salmon populations as well as those injured fishes, birds and mammals whose survival is linked to the overall health of the pink salmon. PWSAC, as the regional aquaculture corporation in PWS, recognizes its vital role and supports the notion expressed by Dr. George Rose that "experimental management can be done at PWS using hatcheries in collaboration with the SEA research proposal". PWSAC has been and will continue to be heavily involved in the ecosystem research envisioned by the EVOS Trustee Council as necessary for restoration of PWS.

Finally, the project described here is an integral component of the integrated ecosystem based research called the Prince William Sound System Investigation. This amalgamation of research projects includes the SEA program studies. The ADF&G is the lead agency on the Prince William Sound System Investigation and several of the other Trustee agencies are acting in a cooperating capacity.

PROJECT DESCRIPTION

1. Resources and/or Associated Services:

This project is a critical component in research and restoration of PWS pink salmon because it will allow control of key variables that are thought to effect early marine growth rate and mortality. In addition, pink salmon are thought to play an important role in the survival of other fishes, birds and mammals. This project will help identify those other species and the importance of pink salmon to each.

2. Relation to Other Damage Assessment/Restoration Work:

This project is integral to the SEA program research planned for 1994. Further, this project has been identified as a necessary component of any ecosystem based research in PWS. Included in this project is the continuation of a spring time macro-zooplankton sampling program at each salmon hatchery. This program will compliment the SEA program research by continuing a 12 year long database that is crucial to understanding pink salmon population dynamics.

3. Objectives:

The goal of this project is, through collaboration with the SEA program, to assist "to develop an ecosystem level understanding of the natural and man-caused factors influencing the production of pink salmon...in PWS". Specific objectives are:

A. Provide SEA researchers, in 1994, with the tools needed to determine the effect of ocean-entry timing, ocean entry location, and fry size on losses to predators.

B. Provide, in 1994, through the hatchery release of pink salmon fry, support necessary to conduct Prince William Sound ecosystem investigations that will provide further information that will aid in understanding hatchery and wild stock interactions.

C. Provide SEA researchers with the tools needed to determine the migratory path of pink salmon fry in PWS.

D. Monitor macrozooplankton abundance, ocean temperature, and meteorological conditions at three hatcheries in PWS.

E. Coded wire tag and release 1,000,000 hatchery pink salmon fry.

4. Methods:

Approximately 411 million pink salmon eggs will be taken at three hatchery locations in PWS in the fall of 1993. Eggtake estimates by facility are as follows: 1) 126 million eggs for the Armin F. Koernig (AFK) hatchery on Evans Island in southwest PWS, 2) 180 million eggs for the Wally Noerenberg Hatchery (WNH) on Esther Island in northwest PWS, 3) 105 million eggs for the Cannery Creek Hatchery (CCH) in Unakwik Inlet in northern PWS. Eggs are taken from brood stock returning to each facility.

All pink salmon eggs will be incubated at their respective hatcheries in aluminum egg boxes with a loading density of approximately 305,000 eggs per box. Eggs will be monitored throughout the fall and winter to assure a clean incubation environment is maintained. This involves continual monitoring of water quality parameters such as dissolved oxygen, pH, total water hardness, and ammonia as well as adjustment to water flow. Removal of dead eggs is important to prevent fungal growth within the incubators and is done prior to hatch with forceps or by hand. Periodic "venting" of incubators is required to purge air bubbles that build up below the perforated plate and prevent adequate water flow to the eggs. Newly hatched pink salmon fry (Alevins) exist in the incubators, feeding off their yolk sac, until early to mid March.

By mid March, 0.23 gram pink salmon fry begin exiting the incubators volitionally and are carried, via gravity flow, through plastic plumbing and a bank of electronic fry counters. Following enumeration, the pink fry are conveyed via flex hose to 12m X 12m X 3m (450m3) saltwater rearing pens. Fry loading density per saltwater pen varies by location, ranging from 7,000,000 fry to 12,500,000 fry per pen. The higher densities are possible in deeper bays such as at WNH hatchery.

During outmigration, 1/2mm Coded Wire Tags (CWT) will be applied to approximately 1 out of every 600 fry. Each pen of fry will contain a unique code. The CWT fry are integral to tracking migration patterns of pink fry, and estimating fry growth and mortality.

All fry will be fed a standard commercial diet of soft semi-moist fish food for 10 - 20 days prior to release. Releases will begin in mid to late April when the calanoid copepods, a key prey item of the pink salmon fry, become available in the upper 20 meters of the water column. All releases will be done in concert with the ship board sampling carried out by the SEA research team. Fry release data from the hatcheries will be communicated to biologists on board trawl and purse seine vessels to assure nearshore and open water sampling is targeted on released fry.

Approximately 371,000,000 hatchery pink fry will be released in 1994. Releases will occur during and after the zooplankton bloom (from about April 15 to June 1) to assess the influence of timing of ocean entry on predation of pink salmon (see Coordination of Integrated Research Effort below). Fry will be released in groups of 7,000,000 to 36,000,000 to assess the impact of number of fry released on predation and fry growth. Generally, fry release size will be between 0.25 and 0.35 grams. The wide geographic separation of each hatchery will test the influence of location of ocean entry to growth, mortality and migration pattern.

Twice weekly, near shore plankton abundance will be monitored from mid March through late June. Samples are taken in two pre-selected locations near each hatchery site using a 1/2m sample net hauled vertically from 20 meters. Up to three replicates are made per sample location. Samples are transferred to 250ml graduated cylinders and allowed to settle 24 hours. The relative density of zooplankton and phytoplankton as well as their percent composition is determined. The samples are then preserved in 10% buffered formalin for later species identification by SEA researchers.

A sub-project of the SEA program for 1994 will address the influence of fry size at ocean entry on predation by looking at the growth and mortality of large fry (1.5 gram) released late in the season. A separate project description has been prepared for this program.

5. Location:

This project will take place in PWS at the Armin F Koernig hatchery on Evans Island, the Wally Noerenberg hatchery on Esther Island and the Cannery Creek hatchery in Unakwik Inlet.

6. Technical support:

The PWSAC salmon program receives technical support from permitting agencies, University of Alaska Fairbanks, University of Alaska Juneau, and PWS Science Center. The ADF&G pathology lab, genetics lab, and coded wire tag lab are among specific expertise areas overseeing the hatchery salmon program. ADEC provides technical support on terrestial and tidelands concerns. The Cordova ADF&G staff are in constant communication with PWSAC staff to monitor marine conditions and provide technical guidance in hatchery practices.

7. Contracts:

PWSAC contracts barge services for transporting bulk supplies and personnel to each hatchery.

SCHEDULE

The project activities are as follows:

Feb 1994-Apr 1994:	Oversee development of incubating pink salmon eggs and perform routine eggcare and incubation environment monitoring.
Feb 1994-Oct 1994:	Coordinate hatchery operations and provide logistics support such as freight and transportation.
Feb 1994-Jun 1994:	Enumerate, CWT, rear and release pink salmon fry. Assess marine plankton abundance.
Apr 1994-Jun 1994:	Coordinate/communicate releases of hatchery pink salmon fry with SEA research team.

Operations at each hatchery are coordinated by a hatchery manager. Each hatchery manager is responsible for meeting the incubation, rearing and release goals at his/her facility. During the fry release cycle, the hatchery managers will be responsible for communicating release plans and detailed information to the SEA biologist coordinating the pink salmon fry studies. The operations manager is responsible for overseeing the operations at all hatcheries and coordinating involvement in the PWS ecosystem study. The hatchery managers report to the operations manager.

EXISTING AGENCY PROGRAM

PWSAC operates four salmon hatcheries in PWS and one on the Copper River system. Five species of salmon are produced between the five facilities. The total annual operating budget including administrative services and capital and major maintenance replacement for these facilities is approximately $8.0 million.

ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS

Permiting is a significant aspect of the PWSAC salmon program. Hatcheries must recieve extensive permitting prior to construction which address water use and quality, land use, wild stocks and other concerns. Each salmon project must

recieve ADF&G review and permitting with scrutiny for genetic and disease histories, wild stock interactions, fishery management implications and common property benefit. Hatchery sites also require permitting from Department of Army Corp, DNR Lands Division, Forest Service special use or EA permitting if necessary, and ADF&G fish transport permits.

PERFORMANCE MONITORING

Monthly hatchery reports prepared by each PWSAC hatchery manager are forwarded to the operations manager and president. These reports detail on-going results of each production cycle relative to established goals for PWSAC hatchery pink salmon. The parameters measured include total eggs taken, number of eggs surviving to the eyed stage of development, number of fry surviving to emergence, number of fry surviving to release, number of fry released by treatment group, number of fry tagged by treatment group. A summary of pink salmon fry releases by hatchery, day released and tag code will be prepared for inclusion in the SEA program progress reports. All pink salmon incubation and release data will be summarized in an annual report required of all hatchery operators by the ADF&G.

The PWSAC operations manager and production manager travel to all hatcheries for quarterly production reviews, supporting hatchery staff through review of quality standards and production goals. In general, production schedules and procedures are defined in advance of each production cycle. The PWSAC management team and SEA researchers will plan and coordinate the pink salmon fry release schedule to assure the goals of the SEA program are met (as described under Coordination of Integrated Research Effort below).

In addition to monthly reports and annual reports, all CWT data is summarized on D-Base database software provided by the ADF&G. ADF&G quality control standards will be followed throughout tag application and reporting.

All plankton and meteorological data is summarized on a computer spreadsheet provided by UAF. Following the sampling season each hatchery's data is forwarded to UAF where it is added to a larger PWS data base. This data is used by the Cooperative Fisheries and Oceanographic Studies program led by UAF. The data will also be used by SEA researchers studying primary and secondary productivity.

The PWSAC program must also comply with a host of agency regulations which direct production limits and outline specific objectives for hatchery enhancement. Annual review of accomplishments by ADF&G personnel and the Regional Planning Team (RPT), and recommendations for program revisions are processes to guide salmon programs and maintain performance within permitting requirements. (The RPT is composed of ADF&G staff appointed by the Commissioner and representatives from the regional salmon association. The RPT develops specific salmon rehabilitation and enhancement objectives which receive public review and approval by the ADF&G Commissioner).

A report will be provided to the EVOS Trustees describing the results of the 1994 hatchery pink salmon fry release program.

COORDINATION OF INTEGRATED RESEARCH EFFORT

This project is complementary to the SEA ecosystem research studies which will be undertaken in FY94 (project 94320). The timing of the shipboard sampling program is set by the anticipated schedule for release of various groups of hatchery produced pink salmon fry. In particular, those studies looking at salmon growth, salmon predators and prey, primary and secondary production, avian predation and nearshore fish aggregations are collaborating with the hatchery operator to describe pink salmon fry rearing and release plans and establish the protocol for in-season communication and coordination of results in the field.

The funding described for this project is necessary for the production and release of marked groups of hatchery pink salmon in 1994. Because the approved SEA proposal is the first integrated ecosystem study of its kind in PWS, SEA researchers, in consultation with the hatchery operator, recommend the hatchery release strategies employed in 1994 emulate those used in the past by PWSAC. Those three strategies include:

"Early Fed Fry": These fry are held in saltwater rearing pens and fed for 10-20 days prior to release at the peak of the nearshore macro-zooplankton bloom (end of April/early May). This group typically comprises 80%-90% of the total release.

"Direct Release": These fry are held in saltwater rearing pens for no more than 3 days and released because their outmigration timing corresponds with the macro-zooplankton bloom. This group typically comprises 5%-10% of the release.

"Late Fed Fry": These fry outmigrate after the macro-zooplankton bloom and are held in saltwater rearing pens until late May/early June. This group typically comprises 5%-10% of the release.

To assure the goals of SEA are met, potential deviations from the 1994 planned fry release schedule will be communicated between the PWSAC management team and SEA research team prior to and during the field season. As an example, conversations between the PWSAC operations manager, SEA chief scientist and SEA salmon growth/predator study leader suggest that the mild winter weather in PWS could accelerate the macrozooplankton bloom by as much as one week. Because most of the hatchery pink salmon fry are relased into the "bloom", the SEA ship-board sampling schedule has been developed with an "earlier than normal" fry release in mind.

Finally, the hatchery facilities will provide support to the SEA research team during the extended field season. This will include shower and laundry, water for vessels, bunking as needed, some equipment storage, communication assistance, and additional lab space if needed.

PUBLIC PROCESS

Alaska state law requires that PWSAC, as the regional aquaculture corporation in PWS, be comprised of representative of all interested user groups and possess a board of directors "which includes no less than one representative of each user group that belongs to the association". The concept of a regional association is

intended to allow active public participation in the salmon rehabilitation program. The PWSAC board of directors is comprised of: commercial / sport / subsistence / personal use fisherman, native representatives from villages in PWS and the Copper River region, representatives of the fish processing industry and representatives of the communities in PWS.

At their September 1993 meeting, the board of directors endorsed PWSAC's participation in the ecosystem planning effort that had just begun and supported PWSAC's involvement in the PWSFERPG. The board gave high priority to research objectives that addressed the current decline in the PWS pink salmon runs and emphasized the need to include hatchery pink salmon fry releases as part of the larger ecosystem study being developed by PWSFERPG.

PWSAC, other members of the PWSFERPG, and the public participated in a workshop in December 1993 at which the SEA ecosystem plan was endorsed as innovative, reasonable and scientifically testable by a group of independent scientists and agents of the EVOS Trustee council. The SEA plan identifies the hatchery releases of pink salmon fry as important to develop an ecosystem level understanding of the natural and man-caused factors influencing the production of pink salmon.

PERSONNEL QUALIFICATIONS

John C. McMullen

Work Experience

1991-Date: President of PWSAC. Administers a program which features the operations of five salmon hatcheries, and active capital projects program, both of which are supported by a finance department and an administrative support group. Works on legislative and Alaska Board of Fisheries affairs which deal with the future of salmon enhancement programs in Alaska. Deals with the Alaska Department of Fish and Game, and Commerce on issues of hatchery transfer grants and loans, enhancement taxes, and hatchery management plans, and the development of fisheries genetics and fish stocking policies. Serves as a member of the Regional Planning Team (RPT) and the Salmon Harvest Task Force. Works closely with the PWSAC board of directors and executive committee.

1989-1991: Special projects manager for PWSAC. Worked as a liason to the oil industry and State and Federal agencies following the EVOS. Served as a member of the Regional Citizens Advisory Committee (RCAC). Also served as a member of the RPT and the PWSAC Production Planning Committee (PPC).

1986-1987: Fishery advisor (unpaid) to Alaska gubernatorial candidate, Steve Cowper. Responded to questions from advocacy groups and drafted policy statements.

1985-1986: Retired from the ADF&G.

1979-1985: Chief of Operations for the ADF&G Salmon Enhancement Program. Responsible for the development and achievement of the program's fish production objectives and development and management of the Operating and CIP budgets.

Education

1958-1961: Northern Michigan Univ., B.S. Degree in Biology.

1962-1964: Michigan State Univ., Graduate School Fisheries

Jeffrey B. Olsen

Work Experience

1989-Date: Operations manager for PWSAC. Oversee operations of five salmon hatcheries producing five species of Pacific salmon. Work with the PWSAC and regional planning groups to develop fish production goals. Responsible for achievement of hatchery production objectives.

1988-1989: WNH hatchery manager, PWSAC. Oversee operations of PWSAC's largest salmon hatchery. Responsible for production of four species of Pacific salmon.

1986-1988: WNH hatchery assistant manager, PWSAC.

1982-1986: AFK hatchery fish culturist and assistant manager, PWSAC.

Education

1977-1981: Univ. of Washington., B.S. Degree in Fisheries Science

BUDGET (attached)

EXXON VALDEZ TRUSTEE COUNCIL
1994 Federal Fiscal Year Project Budget
October 1, 1993 - September 30, 1994

Project Description: PWSAC - PWS System investigation - Experimental Manipulation. This project aids in the restoration of PWS pink salmon through collaboration with the SEA ecosystem study. 390,000,000 pink salmon fry will be released from three hatcheries at various times and at various sizes to assess the influence of these variables on growth, mortality and migration patterns.

Budget catagory	1993 Project No. Authorized FFY 93	93 Report/ 94 Interim* FFY 94	Remaining Cost** FFY 94	Total FFY 94	FFY 95	Comments
Personnel	$0.0	$0.0	$868.0	$868.0		
Travel	$0.0	$0.0	$36.1	$36.1		
Contractual	$0.0	$0.0	$237.1	$237.1		
Commodities	$0.0	$0.0	$456.7	$456.7		
Equipment	$0.0	$0.0	$152.1	$152.1		
Capital Outlay	$0.0	$0.0	$0.0	$0.0		
Subtotal	$0.0	$0.0	$1,750.0	$1,750.0	$0.0	
General Administration						
Project Total	$0.0	$0.0	$1,750.0	$1,750.0	$0.0	
Full-time Equiv. (FTE)	0.0	0.0	40.0	40.0	0.0	

Dollar amounts are shown in thousands of dollars

Budget Year Proposed Personnel: Position Description	Reprt/Intrm Months	Reprt/Intrm Cost	Remaining Months	Remaining Cost
Wages - permanent			5.0	$512.5
Wages - temporary			5.0	$355.5
Personnel Total	0.0	$0.0	10.0	$868.0

NEPA Cost: $0.0

* Oct 1, 1993 - Jan 31, 1994
** Feb 1, 1994 - Sep 30, 1994

Project Number: 94320
Project Title: PWSAC - PWS Sys. Inv. - Exp. Manip.
Agency: Prince William Sound Aquaculture Corporation

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EXXON VALDEZ TRUSTEE COUNCIL
1994 Federal Fiscal Year Project Budget
October 1, 1993 - September 30, 1994

	Rept/Intrm	Remaining
Travel:		
Travel for permanent and temporary employees.	$0.0	$36.1
Travel Total	$0.0	$36.1
Contractual		
Contracted services necessary for the production and release of pink salmon fry. (Barge service, air taxi service, mail service etc.)	$0.0	$237.1
Contractual Total	$0.0	$237.1

Project Number: 94320
Project Title: PWSAC - PWS Sys. Inv. - Exp. Manip.
Agency: Prince William Sound Aquaculture Corporation

EXXON VALDEZ TRUSTEE COUNCIL
1994 Federal Fiscal Year Project Budget
October 1, 1993 - September 30, 1994

	Rept/Intrm	Remaining
Commodities:		
Commodities necessary for the production and release of hatchery pink salmon fry. (Fish food, camp provisions, fuel, etc.)	$0.0	$456.7
Commodities Total	$0.0	$456.7
Equipment:		
Supplies necessary for the production and release of pink salmon fry. (buckets, towels, lumber, chemicals, hardware, clothing, plumbing, CWT tags, etc.)	$0.0	$152.1
Equipment Total	$0.0	$152.1

Project Number: 94320
Project Title: PWSAC - PWS Sys. Inv. - Exp. Manip.
Agency: Prince William Sound Aquaculture Corporation

SFOS 94-141

#94320M

RESEARCH PROPOSAL

TO: Mr. James Ayers, Executive Director
EVOS Trustees Council, Restoration Office
645 G Street, Anchorage Alaska 99501
(907) 276-8012, -7176 facsimile

FROM: Institute of Marine Science (IMS)
School of Fisheries and Ocean Sciences (SFOS)
University of Alaska Fairbanks (UAF)
Fairbanks, Alaska 99775-1080
and
Prince William Sound Science Center (Science Center)
P.O. Box 705, Cordova, Alaska 99574
(907) 424-5800, -5820 facsimile

TITLE: Sound Ecosystem Assessment (SEA)
Observational Physical Oceanography in Prince William Sound and the Gulf of Alaska (SEA-OCEAN)

PRINCIPAL INVESTIGATORS:

Dr. Donald Schell
Director, Institute of Marine Science
School of Fisheries & Ocean Sciences, University of Alaska Fairbanks (IMS/SFOS/UAF)

Dr. David Salmon
Prince William Sound Science Center &
Affiliate Assistant Professor, IMS/SFOS/UAF

NEW/CONTINUING: New

PROPOSED STARTING DATE: March 1, 1994

PROPOSED DURATION: Two years

AMOUNT REQUESTED: FY94 SEA-OCEAN- Total $ 657.31.
FY95 SEA-OCEAN- Total $ 514.31.

Donald Schell 4/13/94
Donald Schell Date
Director, IMS/SFOS-UAF
(907) 474-7531

David Salmon 4/9/94
David Salmon Date
Principal Investigator
(907) 424-5800

4/12/94
A.V. Tyler Date
Associate Dean, SFOS
(907) 474-6732

4/20/94
Ted DeLada Date
Director, Office of Arctic Research

Joan Osterkamp 4-13-94
Joan Osterkamp Date
Executive Officer, SFOS
(907) 474-7824

G.L. Thomas Date
President, PWS Science Center
(907) 424-5800

EXXON VALDEZ **TRUSTEE COUNCIL**
FY 94 DETAILED PROJECT DESCRIPTION

A. COVER PAGE

Project title: Sound Ecosystem Assessment (SEA), An Ecosystem Research Plan for Prince William Sound -- Observational Physical Oceanography in Prince William Sound and the Gulf of Alaska (SEA OCEAN)

Project ID number: 94320M

Project type: Research/Monitoring

Name of project leader(s): Dr. David K. Salmon, Oceanographer, Prince William Sound Science Center (PWSSC), and Affiliate Assistant Professor, Institute of Marine Science, University of Alaska Fairbanks (IMS/UAF)

Lead agency: Prince William Sound Science Center

Cooperating agencies: University of Alaska Fairbanks (UAF), Alaska Department of Fish & Game (ADF&G), Department of Interior/U.S. Fish & Wildlife Service (DOI/USFWS)

Cost of project/FY 94: $657.31K
Cost of project/FY 95: $514.31K
Cost of Project/FY 96 and beyond: $475.00K + equipment + inflation

Project Start-up/Completion Dates: FY94: March 15, 1994-September 30, 1994
FY95: October 1, 1994-September 30, 1995

Geographic area of project: Prince William Sound and North Gulf of Alaska

Name of project leader: Dr. David K. Salmon

Name of lead agency project manager: Dr. Jerome Montague

B. INTRODUCTION

The chief goal of this study is to improve our understanding of ecosystem level processes in Prince William Sound (PWS), with particular regard to how natural and anthropogenic perturbations influence the ecosystem processes. Recent run failures of wild and hatchery pink salmon, as well Pacific herring stocks, surprised resource managers and fishermen. Given our present understanding of the ecosystem, these run failures were probably *unpredictable*. Further, our present understanding of the marine ecosystem does not allow us to discern whether these run failures were due to natural or anthropogenic processes. These run failures underscore the need to gain a more comprehensive understanding of the PWS ecosystem. In this context, the Sound Ecosystem Assessment (SEA) research plan is initially focused on components of the PWS ecosystem called the "fisheries ecosystem;" this includes those elements of the PWS ecosystem important in limiting the production of fish stocks. The fisheries ecosystem is defined to include the predators, competitors and prey associated with specified target species throughout their life history, as well as environmental processes that act to constrain the production of the target species, their predators, competitors and prey.

The first phase of SEA will focus on pink salmon and Pacific herring stocks as target species, because of their major ecological roles in the Sound, as well as their economic importance to the communities of the Sound. SEA will use an ecosystem level approach. It seeks to identify critical processes that affect survival of the target species and their predators, competitors and prey along the migratory routes that the target species use within the Sound. This approach is possible today because of important groundwork laid by investigators from state and federal agencies and from other research centers. These prior studies established extensive knowledge of many aspects of the life stages of the target species; the SEA approach builds upon this foundation. SEA seeks to combine this prior knowledge with new information and new technologies to complete a quantitative understanding of the ecosystem components associated with the early life stages. SEA also seeks to develop numerical models that simulate those subsystems. We believe this level of understanding is both necessary and sufficient to distinguish between natural and anthropogenic effects. The objective of the SEA project is to use mechanistic, coupled models, in conjunction with data assimilation, to provide nowcasts[1] and short term forecasts of the success or decline of year classes and stocks of the target species. In addition, the results of SEA will provide useful tools for decisions concerning management, enhancement and restoration of these stocks.

The ecosystem perspective used in SEA will identify and analyze both physical and biological processes within the Sound that act to limit the production of the target species. This ecosystem approach is highly applicable to other target species including fish, seabirds and marine mammals. It can be transferred to other geographic regions. Future studies of other target species may be modeled using the migratory pathway approach put forth in SEA.

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[1]Nowcasting is the process of monitoring measurable variables (temperature, predator density, prey density) to predict in real time an unmeasurable variable such as fish survival.

Future studies within PWS will integrate well with the initial studies to identify how components of the PWS ecosystem are linked to one another. Results of future studies will be useful for management, enhancement and restoration of critical elements of the PWS ecosystem.

Single species population dynamics models are inadequate to make preseason predictions of animal abundance for both conservation and economic purposes (Cullen 1989). Without adequate predictive capabilities, restoration and enhancement practices and the impacts of other anthropogenic activities will remain controversial. The growth conditions and the carrying capacity of the coastal marine ecosystem in this region vary interannually, and are influenced by the physical, chemical and biological processes in the Gulf of Alaska (Thomas and Mathisen,1993). The SEA plan assumes that coupling knowledge of the fluctuating carrying capacity and growth conditions of the system to animal population dynamics is an important step towards improving predictive capabilities and, ultimately, developing a better understanding of the ecosystem.

There is general agreement that top-down and bottom-up forces act on populations and communities simultaneously (Hunter and Price, 1992). SEA uses an approach similar to that used in the Global Ocean Ecosystems Dynamics (GLOBEC) Northwest Atlantic Study (1991b). This approach examines the ecology of important species by studying environmental and trophic interactions along their migratory pathways. The SEA program will use the conceptual experimental design of GLOBEC (1991a), which involves the nesting of fine scale measurement programs within large scale ecosystem monitoring efforts. Underlying both the large scale and fine scale measurement programs are the scientific questions that must be answered to improve our understanding of the ecosystem and to improve predictive capabilities for animal abundance.

The disturbing trends in the major fisheries of Prince William Sound following the *Exxon Valdez* oil spill (EVOS) focused public attention on this large, productive coastal environment and how it functions to support marine resources of immense commercial, sport and subsistence value. The fishery resources of the Sound are components of broader marine and freshwater ecosystems that foster their survival. The SEA plan outlines the rationale, scientific methodologies, and research priorities needed to describe the ecological roles of selected fishes and their inter-relationships with other components of the ecosystem (physical, chemical and biological) that limit their annual production and harvest.

SEA identifies the following goals for planning and subsequent studies. Achieving these goals will, ultimately, address scientific and public concerns about the health of this valuable Alaskan coastal environment:

(1) Acquire an ecosystem-level understanding of marine and freshwater processes that interact to maintain levels of fish production in Prince William Sound;

(2) Use this new information to more accurately forecast fishery production and predict fishery responses to different levels of ecosystem disturbance, both natural and anthropogenic;

(3) Establish a comprehensive scientific data base describing the status of the Prince William Sound ecosystem and its fisheries, and also establish a data and information program which serves the needs of the region's residents and improves the information used for management (primarily fisheries), enhancement and mandated restoration activities.

C. PROJECT DESCRIPTION

1. Resources and/or Associated Services:

Observational Physical Oceanography in Prince William Sound and the Gulf of Alaska

The Sound Ecosystem Assessment (SEA) program evaluates changes occurring in the Prince William Sound (PWS) ecosystem in the context of groups of interacting species. Implementation of the SEA program will result in vital knowledge for determining the feasibility of, and the approach to, restoration of many resources and services injured by the Exxon Valdez Oil Spill (EVOS). Resources addressed by SEA include pink salmon, herring, and the principal species interacting with these fishes. These pelagic organisms support a host of birds and mammals, some of which are listed as injured species of the EVOS. Services addressed include subsistence, commercial fishing, recreation and tourism, and passive use. While SEA is primarily a monitoring and research activity, this program will also support other EVOS Trustee Council programs (i.e., providing better information to land and fisheries management personnel that will promote a healthy ecosystem, and increasing public awareness of the state of the ecosystem).

The SEA program was developed by the Prince William Sound Fisheries Ecosystem Research Planning Group (PWSFERPG). This group is comprised of scientists, community residents, resource users and managers of Prince William Sound. The SEA plan was developed with the encouragement and support of the EVOS Trustee Council to provide an understanding of important ecological influences on injured resources and services. The draft SEA plan (with related technical information) was peer reviewed by independent scientists and agents of the EVOS Trustee Council at a workshop in December 1993. The reviewers endorsed the plan, calling it innovative, reasonable, and scientifically testable. Future expansion of the SEA program will involve coupling pelagic and nearshore benthic ecology and linking aquatic and terrestrial ecology through dominant ecosystem pathways.

2. Relation to Other Damage Assessment/Restoration Work:

Background: Physical Oceanography and Meteorology of Prince William Sound and the Gulf of Alaska

The climate in PWS is maritime and is influenced by a nearly continuous procession of low pressure systems. Adiabatic uplift of the moisture-laden air masses delivers precipitation as rain and snow to the coastal region each year (Royer, 1979). Mean annual precipitation totals approximately 200 cm with pronounced seasonal variability among weather stations

(Royer 1978). Minimum precipitation occurs in June and July (10 cm month^{-1}) with a maximum in September and October [25 cm month^{-1} (Royer 1978)]. The annual discharge cycle for coastal rivers reflects the release of stored winter precipitation which peaks in May and June.

The annual cycles of temperature and salinity in PWS waters are forced by freshwater input, seasonal shifts in large-scale weather patterns, and by interaction with the surface and deep water of the bordering open ocean. Active exchange of water with the open Gulf of Alaska (GOA) occurs through Hinchinbrook Entrance (HE) and Montague Strait (MS) (Schmidt, 1977). Wind intensities are greatest from October to April (Wilson and Overland, 1986). Cyclonic winds associated with the passage of storm systems over the Gulf drive an onshore Ekman transport that results in strong coastal convergence, downwelling outside PWS, and the transport of surface water (upper 150 meters) northward through HE. As winter progresses, the surface-mixed layer cools to between 2 and 4 °C, and surface salinities increase to nearly 32 parts per thousand. The upper layers of the Sound are generally coldest and most saline in March.

Following a transition in weather patterns in late April and May, the period of strong onshore Ekman transport is replaced by occasional offshore transport and weak upwelling outside of the Sound due to a relaxation of wind-forcing. These periodic flow reversals occur intermittently from late May to September. Under these conditions, deeper, more saline oceanic waters intrude onto the shelf south of PWS. When the density of this intrusion exceeds the density at the depth of sills (180 meters) in sea valleys outside the Sound (HE and MS), a period of deep water renewal is initiated. The duration and magnitude of this annual event is governed by the nature of the period of relaxed onshore wind forcing. During the summer and early fall, surface waters of the region are freshening in response to local rains and the melting winter snow pack.

Upper-layer (100 meters) circulation patterns in PWS are also driven by freshwater input, local winds, and interactions with the Alaska Coastal Current (ACC) flowing westward around the margin of the Gulf (Royer, 1981). Upstream of the Sound the ACC is augmented by freshwater inputs from glaciers (Royer et al., 1990) and rivers that ring the Gulf. A portion of the ACC enters the Sound through HE, traverses the region from east to west and then exits through MS (Niebauer et al. 1993). The magnitude and direction of this ACC inflow depends on multiple variables such as seawater density gradients, atmospheric pressure differences within and outside of the Sound, regional winds, and seasonal changes in the internal Rossby radius of deformation (Royer et al., 1990). Seasonal variability in the ACC has been addressed by Johnson et al. (1988) and modeled by Luick (1988). A cyclonic circulation cell has been observed in the Sound about 30 kilometers (km) north of HE (Muench and Schmidt, 1975), and is likely related to interactions between the bathymetry, the regional wind field and ACC inflow. Under summer and early fall conditions of reduced onshore transport and increased freshwater input, substantial surface outflow can occur through HE.

The large scale wind driven upper layer circulation in the GOA consists of a cyclonic gyre, with broad slow currents in the southern and eastern Gulf, and an intense western boundary current (the Alaskan Stream) on the northern margin. The circulation is also characterized by the occurrence of mesoscale (100 - 300 km diameter) anticyclonic eddies, some of which

propagate westward along the northern margin of the Gulf (Musgrave et al., 1992). Others, such as the Sitka eddy (Tabata, 1982) are essentially standing features. These features appear to be important in the transport of properties onto and off of the continental shelf, and may also affect the timing and migration patterns of salmon stocks returning to the coastal region to spawn (Hamilton and Mysak, 1986).

The GOA is characterized by large interannual variations in the atmosphere and ocean. This variability exerts considerable control over changing environmental conditions in the Sound on time scales of years. Variations in the frequency and intensity of storm systems that enter the Gulf (or form there) translate to variable amounts of precipitation in the coastal mountains, which in turn produces changes in coastal runoff and the intensity of the flow into the Sound from the ACC. Periods of increased storminess bring higher air temperatures to the subarctic North Pacific, while periods of decreased storminess result in lower air temperatures (*cf.* Salmon 1992). Changes in the timing and intensity of spring runoff occur partly due to prevailing air temperatures in the region in late winter and early spring.

The most prominent cyclic time scales of interannual variation that occur in the atmosphere over the GOA are those at periods of about 3 and 5 years. These variations appear to be linked in the atmosphere and ocean to large scale changes occurring in the tropical Pacific in relation to El Niño, La Niña, and the Southern Oscillation (ENSO). Thus, there is a tendency for changes in North Pacific storm frequency and intensity to occur on these time scales. The atmospheric variations over the GOA and central North Pacific also translate into changes occurring within the oceanic environment of the Gulf in terms of chemical properties and ocean currents (Tabata, 1991a, 1991b; Salmon, 1992). In particular, ocean circulation in the subarctic tends to be stronger during El Niño warm events and weaker during the La Niña phase of the cycle, largely in response to variable wind forcing. Currently, it is not known whether the 3 and 5 year time scales are the most important determinants of interannual variability in PWS.

Decadal scale variability in the physical environment of the North Pacific occurs in conjunction with phenomena that are both cyclic and quasi-periodic. Low frequency variations related to the 18.6 year nodal tide cycle occur in time series of both atmospheric and oceanic parameters in the eastern North Pacific (Royer, 1989; 1993). This 18.6 year variability shows up clearly in Gulf of Alaska air and ocean temperatures and a time series of recruitment of Pacific halibut, *Hippoglossus stenolepis* (Parker et al., 1993). Decadal scale variability in the North Pacific also occurs in relation to quasi-periodic ENSO phenomena. For example, from 1976 through 1988 the environment of the North Pacific was characterized by large and persistent anomalies of air and sea surface temperatures as well as upper level and surface winds that can be partially linked to variations occurring in the tropical Pacific in relation to ENSO. (Trenberth 1990; Salmon 1992). North Pacific ecosystems have responded to these persistent anomalies through increases in biomass of phytoplankton in the central North Pacific (Venrick et al., 1987), and increases in abundance of zooplankton, pelagic fishes, and squid in the subarctic North Pacific (Brodeur and Ware, 1992). Within PWS however, the effects of decadal scale climatic forcing on the ecosystem have not been demonstrated and are poorly understood.

The SEA Approach: Connecting the Physics to the Ecology in PWS

Major hypotheses in the SEA program include the idea that the physical environment of PWS and the GOA is the major determinant of natural variability in the ecosystem. In particular, changes in the large scale advective regime in PWS are thought to constrain growth and survival of juvenile pink salmon, both through differential availability of important food resources (calanoid copepods) and through a prey switching mechanism by which presence or absence of these resources causes potential pink salmon predators to feed more heavily on either pink salmon or copepods. The elucidation of the physical oceanographic structure of PWS, and its space/time variability is critical to understanding how the ecology of the region changes in response to natural perturbations such as the ENSO phenomena and large scale and long term temperature fluctuations associated with the 18.6 year nodal tide. This project will characterize and monitor major physical processes (atmospheric and oceanic) that constrain the ecology of pink salmon, their predators, and their prey in PWS. Information concerning the origin, modifications, and fate of water masses that constitute both the surface and deep waters of PWS and determine their biology will be obtained in PWS/GOA. Large scale physical oceanographic measurements will consist of temperature, salinity, and ocean currents (derived density and baroclinic ocean currents) obtained from conductivity/temperature/depth and acoustic doppler recording instruments. Meteorological measurements will include air temperature, precipitation, wind speed and direction and derived products that relate atmospheric forcing to oceanic structure, properties and circulation. Fine scale oceanographic measurements will include determination of horizontal and vertical physical structures (e.g. thermocline, pycnocline, fronts, eddies, tidal rips, shear zones). This study will be closely coordinated with all components -- research projects -- of SEA. In particular both chemical (silicate, phosphate, nitrate, oxygen) and biological data (phytoplankton, zooplankton, ichthyoplankton) will be used as physical oceanographic tracer fields in the determination of how physical processes in PWS act to control the fluctuations of ecological populations.

3. Objectives:

Objectives of SEA Observational Physical Oceanography

The objectives of the physical oceanography program within SEA are as follows:

(1) Determine the space/time variability of atmospheric and oceanic processes and structures within PWS and the GOA. Atmospheric processes of interest will include winds, precipitation and temperature, while the focus in the ocean will be on currents, fronts, eddies, tidal rips, thermocline, halocline, and changes in properties (both physical and chemical) of both the surface and deep waters.

(2) Determine the relationships and interactions between atmospheric forcing (winds, storms, long term temperature changes) and wind and buoyancy driven ocean currents in PWS/GOA.

(3) Determine how the relationships described in (2) act to retain or disperse major

food resources for ecologically important species within PWS.

(4) Ascertain the large and fine scale oceanographic structure and the major climatic cycles (ENSO, nodal tide) and events (e.g storms) that affect PWS/GOA within the context of the space/time distributions and changes in abundance of important populations in these regions.

4. Methods:

Large Scale Physical Oceanography in Conjunction with the River/Lake Hypothesis

The large scale measurements made in the SEA physical oceanography program are crucial to testing the validity of the river-lake hypothesis. Baseline information concerning the water masses that constitute the externally advected surface and deep waters of Prince William Sound will be obtained from transects in the Gulf of Alaska (local freshwater input to PWS will be estimated from stream measurements and a hydrologic model). These oceanographic sections will cut across the Alaska Coastal Current (ACC) and the deep shelf waters in the northern Gulf of Alaska. Baseline physical information will consist of temperature, salinity, density and dissolved oxygen profiles obtained from conductivity/temperature/depth (CTD) measurements (augmented by an oxygen sensor), ocean current velocities obtained from acoustic doppler current profiler (ADCP) measurements and (geopotential) dynamic heights calculated from CTD data. ADCP backscatter will also be used in SEA investigations to augment biological (i.e. net capture) measurements of zooplankton distribution and abundance. Chemical signatures (nitrate, silicate, and phosphate, possibly tritium or other tracers) of ACC and shelf derived waters will be obtained from Niskin bottle samples mounted with the CTD on a rosette. Conservative nutrient based tracers (NO and PO, cf. Broecker 1974) will be computed from the nutrient distributions because of their utility in ascertaining distinctions between water masses (cf. Salmon and McRoy, 1994). These tracers will be particularly useful for discerning deep water characteristics. In addition, the biota found in ACC waters are distinct from those found on the deep shelf (i.e. neritic versus oceanic) and will be used as tracers to further discern differences between water masses that enter the Sound via Hinchinbrook Entrance (HE).

Transects across HE, southwestern PWS, Montague Strait (MS), and regions of the central Sound will be made to determine the advective regime within PWS. Sampling will encompass the entire water column in shallow regions or down to about 600 m in the deeper areas of the Sound. This will allow for the determination of both surface water flushing patterns (and rates) and deep water renewal processes in the Sound, as well as the abundance of associated deep and near surface zooplankton assemblages. Sampling will include CTD, ADCP, and chemical measurements (Zooplankton sampling techniques are described in the zooplankton sampling program). Ocean current sampling will be conducted over the course of several tidal cycles in order to determine the relative contribution of tidal currents to the net flow regime. In the southwestern Sound, physical and zooplankton sampling will be conducted for all passages that drain out of PWS. ADCP and CTD transects will be run across Elrington and LaTouche Passages as well as across Port Bainbridge to include (presumably) outflow from Bainbridge and Prince of Wales Passages. Further north,

transects will be run across Knight Island Passage and MS to determine the relative contributions from these areas. Physical and zooplankton sampling in the southwestern Sound will be conducted in close coordination with predator and juvenile salmon sampling.

Four vessels will be equipped with CTD instruments. Three of these vessels will intensively sample in western PWS, one being based in the southwestern region in close proximity to MS. One CTD in western PWS will be towed from a large mid water trawler on a fish that is also mounted with a fluorometer, optical plankton counter and a dissolved oxygen sensor. One CTD will be mounted on a rosette for use in chemical oceanographic sampling. This instrument will be used both in the MS and HE/GOA regions, and will be deployed aboard a seining vessel, and occasionally on vessels of opportunity. The two other CTDs will be used for fine scale surveys in conjunction with salmon predation and growth studies in both the northwestern and southwestern Sound. The fine scale sampling is described below in a separate section. Initially one ADCP will be deployed aboard a vessel that will alternately sample in western PWS, concentrating on the region of outflow to the GOA (which includes MS). This vessel will also work frequently in HE and the adjacent GOA to characterize flow in the ACC, determine how much of this flow is deflected into PWS, and determine the shelf water contribution into PWS. ADCP backscatter will be used in conjunction with net sampling to determine densities of zooplankton in these regions. Chemical and biological sampling will provide data to assist in determining the advective regime and its source waters in the Sound in both time and space. Station spacing along transect lines within central PWS and the Gulf of Alaska will be approximately 5 km. Station spacing within HE and MS will be about 2 km. Later in the field season 2 ADCPs will be utilized, one aboard a vessel in western PWS and one in the HE/GOA region. This instrument (HE/GOA) will be used alternately aboard a vessel and in a self contained moored deployment within HE. The moored deployment is also anticipated to be used over the winter months to determine the flow field in response to intense atmospheric forcing, and the presence/absence of biological scattering layers . The principal and most intense sampling periods for CTD, ADCP and chemical measurements will occur from April through July. Measurements will also be made in the fall and winter months to determine how the regional oceanography and meteorology fits into the larger scale variability (i.e. interannual variability). The months of April and May will be sampled most intensively in HE, the GOA, MS and the central Sound, since the correlations observed between zooplankton abundance and atmospheric forcing are strongest during these months (Cooney and Salmon, unpublished data).

Meteorological data (sea level pressure, air temperature, humidity, wind speed and direction) will be obtained onboard of the sampling platforms, and will also be obtained in a nearly continuous fashion from meteorological buoys moored within PWS. These meteorological buoys will be equipped with oceanographic sensors (fluorometer, thermistor chain) to augment the data obtained from the mobile sampling platforms. Satellite tracked drifting buoys will periodically be deployed in the Sound to track surface ocean circulation patterns and their evolution throughout the year.

In terms of temporal sampling frequencies, routine sampling transects will be run on time scales of hours to weeks depending on the problem being pursued. For example physical measurements during daytime and nighttime transitions in feeding behavior will be conducted on time scales of hours, while changes in large scale advection will be determined on scales

of days to weeks. There will also be an opportunistic, event-driven component to the sampling regime that will maximize the flexibility and, therefore, optimize the conditions under which certain types of sampling occur. An example of event-driven sampling in field investigations is in determining the advective regime and associated plankton assemblages before, during, and after the passage of major low pressure systems through the PWS/GOA region. Another example would be for intense sampling to occur during periods when large schools of predators are observed in PWS.

Vessels of opportunity will also be employed in obtaining large scale physical and biological oceanographic data in the SEA program. A tanker vessel makes a transit from Valdez, Alaska to Honolulu, Hawaii once every three months. During the course of transit, the vessel meridionally transects both PWS and the GOA. The data taken from these vessels have, thus far, included standard weather data and expendable bathythermograph (XBT) data. Expendable CTDs (XCTDs) could easily and productively be used in place of XBTs. The advantage of using XCTDs is that their data allow for discerning changes in the surface and deep salinity fields, as well as computation of the baroclinic geostrophic component of the oceanic circulation, both in PWS and the GOA, whereas XBTs only provide ocean temperature data. This convenient and relatively inexpensive source of gathering data will provide valuable information in terms of ocean state, particularly in relation to atmospheric forcing. Both the state ferries and the Ship Escort Response Vessel System (SERVS) vessels can be instrumented to provide quasi-synoptic oceanographic and atmospheric data within PWS. It is envisioned that the SERVS vessels would be used for physical, chemical and biological data using CTD, ADCP, OPC, fluorimetry and possibly some nets for zooplankton and ichthyoplankton. Both the SERVS vessels and the state ferries would be used for XBT and XCTD work. The SERVS vessels will also be equipped with ADCP, as well as optical and sonar gear for biological data collection.

In addition to directly measured oceanographic and atmospheric variables, SEA physical oceanography will use prepared data products. In particular, these will include satellite imagery when available (e.g. AVHRR, CZCS, and possibly SAR), and large scale atmospheric pressure and downwelling index data for the North Pacific (available from Fleet Numerical Oceanographic Center, Monterey, CA). These data have been utilized in initial analyses of relationships between zooplankton and atmospheric/oceanic forcing (Salmon and Cooney, unpublished data). Large scale North Pacific sea surface temperature fields (available from Scripps Institution of Oceanography, La Jolla, CA) have been obtained on a periodic basis for updates and computations of anomalies over large regions of the North Pacific that have been identified in empirical orthogonal function analyses (cf. Weare et al., 1976; Kawamura, 1984; Namias et al., 1988; Wallace et al, 1990; Salmon, 1992). Aerial photography will also be employed to determine the large scale distribution of mesoscale features in the Sound, particularly tidal rips and shear zones (these are expected to be regions of large aggregations of biomass of both plankton and nekton).

Fine Scale Physical Oceanography

Western PWS Salmon Outmigration/Predation/Growth Study

Measurements of mesoscale and fine scale oceanographic features are essential for the

thorough characterization of environmental conditions in the western Sound that constrain the growth and survival of the species being studied (pink salmon, their predators and their prey). Closely spaced CTD measurements will be made in conjunction with ADCP sampling to elucidate the fine scale physical structure (e.g. thermocline, pycnocline, fronts, eddies, shear zones) within the western regions of the Sound, particularly in relation to the distributions of phytoplankton, zooplankton, juvenile salmon and salmon predators such as juvenile pollock and cod. These measurements will address physical conditions that characterize diel vertical migrations of these species. Two Seabird Seacat CTDs will be used in the characterization of fine scale structures. These instruments are highly portable and self contained and will be transferred back and forth between the larger seiners for offshore and nearshore work, and the small skiffs for inshore measurements. The ADCP will principally be used for characterizing the large scale velocity field in western PWS. It will occasionally be deployed aboard the seiner or a small skiff for nearshore work, particularly in relation to characterization of velocity fields related to small scale frontal structures and nearshore tidal rips.

Integration of Large and Small Scale Physical Oceanography

The migratory pathway that the salmon use during their outmigration from the Sound will be characterized in terms of its physical (and biological) oceanographic structure. The problem of whether these animals utilize specific physical conditions and oceanographic structures during their outmigration will be addressed. This will be accomplished through the integration of large and small scale horizontal and vertical measurements made in western PWS. Aerial surveys and possibly satellite images will be used to facilitate oceanographic sampling of physical features (such as fronts and tidal rips) that are visible from the air (with either a visible or thermal signature).The sampling frequency will be highest during the months of April through June, with less frequent sampling in July and August. Horizontal spatial sampling scales will range from meters to kilometers and vertical scales will range from meters to hundreds of meters.

Large and small scale physical, chemical and biological data will also be assimilated into numerical models of the deep and surface circulation in the GOA and PWS. The modeling efforts are described under a separate project (Information Systems and Modeling).

Fall and Winter Oceanographic Measurement Programs

Winter surveys of both large and small scale physical properties and structures within the PWS/GOA region will be conducted in order to fit observed environmental conditions within the context of the very substantial interannual variability that governs the meteorology and oceanography of the North Pacific. In particular, the physical transitions from El Niño to La Niña conditions will be documented in order to assess and predict changes in the structure and distribution of animal and phytoplankton assemblages as they respond to these environmental regime shifts. The nature and phasing of large scale and long term temperature changes in PWS in relation to the (18.6 year) nodal tide will also be addressed. CTD, ADCP and chemical data will be used to characterize the overwintering environment for herring (and, possibly other forage fishes such as pollock, tom and true cod, capelin, sandlance, and smoothtongue smelt). ADCP backscatter data will also be used to augment

(net) measurements of zooplankton distribution and abundance. These measurements will dovetail with and provide temporal continuity for the ongoing NOAA forage fish study to be conducted during spring and summer months. Larval drift studies (herring in the ichthyoplankton stage) will be conducted using ship (and, possibly satellite) tracked drifters. Physical and chemical properties of the water in which the plankton are adrift will be measured using CTD and standard chemical measurements.

Data Management

The SEA physical oceanography program will generate large amounts of data due to the length of the field season and the nature of the instrumentation used for observational sampling. The management of the data is budgeted under a separate program (Information Systems and Modeling) and will integrate the data collected in all SEA programs. It is critical to the success of the physical oceanography program (and all other components of SEA) that the data management be funded at an appropriate level. The approach taken here is non-traditional in that data management is usually budgeted for within each component of a research program. It is anticipated that this new approach will allow for a fast turn around time on preparing the data for analysis by the field investigators and will also result in numerous data sets to be online in an easily usable and accessible format that will facilitate an integrated and interdisciplinary analysis of the data.

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5. Location:

Field research will be conducted in Prince William Sound and the North Gulf of Alaska. Data analysis will be completed at the PWS Science Center in Cordova and at the Institute for Marine Sciences/University of Alaska Fairbanks.

6. Technical Support:

Technical support for the physical oceanography program will consist of: (1) System commissioning and startup support for two Acoustic Doppler Current Profiler systems; (2)

Vessel charters (25 days) for work in Hinchinbrook Entrance, the Gulf of Alaska, and Montague Strait.

7. Contracts:

Vessel charters will be contracted for 25 days of work in Hinchinbrook Entrance, the Gulf of Alaska and Montague Strait. The vessel contracts will be awarded through competitive bid. Contracts will also be necessary for system commissioning and start-up support for two Acoustic Doppler Current Profiler systems. These will be a sole source contract because there is only one manufacturer of these systems. Competitive bidding will be used in all situations except in cases where only one manufacturer or technical support service is available.

D. SCHEDULES

Field Work will be initiated on April 15, 1994 and will be concluded on or around September 1, 1994. (See attached vessel schedule and schedules for salmon predation/growth/survival studies for detailed dates of anticipated field surveys.)

The Principal Investigator (David Salmon) will be in the field April 15- September 1, with intermittent days in port every 10 days to 3 weeks. After September 1 the PI will be based in Cordova for data analysis, draft and final report writing and journal publication preparation.

Dr. Mark Johnson will devote 1 month to this program. He will go on one cruise and will work on analysis of observational data and development and implementation of numerical models for SEA.

The Technicians will be in the field between April 15 and September 1, with intermittent days in port. One technician will spend significant amounts of time in Cordova engaged in the editing and analysis of physical oceanographic data. After August 1, both technicians will assist the PI and Associate Scientist in the analysis of data, the preparation of draft and final reports, and the preparation of journal publications.

The marine engineer will build and design the mooring in Cordova and will be in the field for deployment and recovery of the instrument package.

The Graduate Student will spend part of the spring and summer in the field assisting with data collection, and will be responsible for analyzing data that will pertain to a specific sub-problem within the SEA program.

It is anticipated that data compilation and analysis will begin within several days of the completion of the first field survey. This will be an ongoing assimilative process throughout the spring and summer. Near real time data will be edited by a full time staff of computer system and data managers under the direction of Dr. E. Vincent Patrick of the PWS Science Center and the University of Maryland. Dr. Patrick's staff will work in close coordination with Dr. Salmon and his field staff to have high quality data available for analysis, integration with

other data sets compiled during the 1994 SEA field season and the production of draft reports beginning early in and continuing throughout the field season. This powerful approach to data management will also allow maximum flexibility to adjust the field sampling program and optimize the collection of field data to obtain sound scientific results.

Physical Oceanography/Zooplankton/Chemical Sampling Vessel Schedule for 1994

(Physical, chemical and zooplankton sampling will also be conducted aboard 3 other vessels in western PWS in association with salmon and predator growth/survival/predation studies)

April 17-19	Hinchinbrook/Montague Strait
April 26-28	Hinchinbrook/GOA/central Sound
May 9-11	Hinchinbrook/Montague Strait
May 22-24	Hinchinbrook/Montague Strait
June 1-3	Hinchinbrook/Montague Strait
June 12-14	Hinchinbrook/GOA/central Sound
June 23-24	Hinchinbrook/Montague Strait
July 8-9	Hinchinbrook/GOA/central Sound
July 29-30	Hinchinbrook/GOA/central Sound
Sep 1	Hinchinbrook/GOA/central Sound

E. EXISTING AGENCY PROGRAM

No federal or state agency program currently exists that could be described as an ecosystem framework for studying resources in Prince William Sound and the EVOS region. For the physical oceanography component of the 1994 SEA field program, the PWS Science Center will contribute resources in the form of deep sea reversing thermometers and Nansen water sampling bottles. This equipment will be provided at no charge and will be used for the calibration of CTD measurements of ocean temperature and salinity.

F. ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS

The only permits that could be necessary for the 1994 SEA program are those that would be required for mooring equipment near the tanker lane in Hinchinbrook entrance. The United States Coast Guard has been contacted and we have received their assurance that a joint and cooperative effort will be undertaken to ensure that the gear is deployed in a manner that will not interfere with any shipping operations in the region (Lt. Commander James Beckham, USCG, personal communication, 1994). The physical oceanographic program of SEA 1994 should qualify for a categorical exclusion in terms of compliance with the National Environmental Policy Act (NEPA).

G. PERFORMANCE MONITORING

The chain of command is as follows:

Project Leader: Dr. David K. Salmon, Oceanographer PWS Science Center and University of Alaska (backup project leader Dr. Gary Thomas)

Technician
Technician
Marine Engineer
Graduate Student
(backup personnel for technicians will be drawn from a pool anticipated to be generated from the nationally circulated job advertisements for these positions; backup personnel for a graduate student will be selected from a nationally advertised pool as well)

The project leader will be responsible for project management and will delegate responsibility within the project as he sees fit. The project leader will, in turn, be responsible to his supervisor at PWS Science Center (Dr. G. L. Thomas).

H. COORDINATION OF INTEGRATED RESEARCH EFFORT

The SEA physical oceanography program will be closely coordinated with other components of the SEA field and modeling studies. All of the physical oceanographic field surveys will be conducted in conjunction with a combination of chemical oceanographic and phytoplankton sampling, zooplankton assessment and capture, and nekton (both juvenile and adult fish) assessment and capture. Also, marine mammal and bird observers will be onboard some of the sampling vessels in coordination with projects 94102 (murrelet prey), 94159 (marine bird surveys) and 94173 (pigeon guillemot). The SEA program will be integrated with project 94163 (forage fish study) whenever possible and appropriate. Also the SEA program will be coordinated with ADF&G projects that relate to pink salmon and herring but were underway before the initiation of SEA planning efforts. These include projects 94166 (herring spawn deposition survey), 94184, 94185 (coded wire tagging studies), 94187 (otolith marking), and 94191 (oil related egg and alevin mortalities). In addition, the field results from the physical oceanography program will be integrated into both numerical and analytical models of the PWS ecosystem that include oceanographic parameters and animal (and phytoplankton) distributions.

I. PUBLIC PROCESS

Sound Ecosystem Assessment (SEA) is an ongoing project with a mission to develop and advocate the best model for ecosystem research in Prince William Sound and the EVOS affected region. The concept of the SEA program has been in the region for several years. Since August of 1993 the plan has been under intense development and come to fruition as a working document to guide ecosystem research in PWS and the EVOS region. The SEA Science Committee includes scientists and resource managers from the University of Alaska, Alaska Department of Fish and Game, PWS Science Center, U. S. Forest Service and PWS Aquaculture Corporation. There has been a tremendous amount of public input into the formulation of this project. Input has been received from Prince William Sound Communities Organized to Restore the Sound (PWSCORS), Cordova District Fisherman United, Cordova

Aquatic Marketing Association and numerous Prince William Sound fisherman. A workshop sponsored by the EVOS Trustee Council and NOAA was held in Cordova Alaska during December of 1993 to peer review the SEA document and to further plans for coordinated and integrated ecosystem research in Prince William Sound and the greater EVOS affected region.

J. PERSONNEL QUALIFICATIONS

Project Leader: David K. Salmon Ph.D.
Oceanographer, Prince William Sound Science Center
Affiliate Assistant Professor, Institute of Marine Science, University of Alaska
Research and Development Coordinator, Prince William Sound Oil Spill Recovery Institute

Education:
Ph.D. 1992, Physical Oceanography, University of Alaska Fairbanks, Advisor T. C. Royer
B.A. 1985 Mathematics, Chemistry minor, Humboldt State University

Professional Experience:
1993-present Scientist at PWS Science Center
1993-present Affiliate Faculty Univ. of Alaska
1992-93 Postdoctoral Fellow Institute of Marine Science, University. of Alaska
1987-92 Research Assistant, Institute of Marine Science, University. of Alaska.
1985-87 Research Assistant, Dept. of Mathematical Sciences, University. of Alaska

Field Experience in Prince William Sound and the Gulf of Alaska:
Participated in the collection of physical, chemical and biological data in PWS and the Gulf of Alaska during research cruises in these regions, 1987-1991.
Collected physical, chemical and biological data during research cruises in PWS following the Exxon Valdez oil spill, 1989-90.

Selected Publications and Presentations:
Salmon, D. K. and C. P. McRoy 1994. (in press), Nutrient based tracers in the western Arctic: A new lower halocline water defined, in: *The Role of the Polar Oceans in Shaping the Global Climate*, American Geophysical Union.

Salmon, D. K. 1993. Long and short term climate driven processes that affect fisheries production in Prince William Sound and the Gulf of Alaska, EVOS Trustee Council/NOAA workshop on Ecosystem Research, Cordova AK December 1993, and Invited Public Lecture, Cordova AK, December 1993.

Oceanic Interdecadal Climate Variability, 1993. (co-authored with 10 others), International Oceanographic Commission of UNESCO, Technical Series Report #40.

Salmon, D. K. 1993. Aspects of the Meteorology of the Gulf of Alaska, Institute of Marine Science Technical Report, prepared for Arco Marine.

Salmon, D. K. and L. B. Tuttle, 1992. Variability in the physical environment of the North Pacific from the 1940s through the 1990s, abstract, Proc. American Fisheries Society.

Salmon, D. K. 1991. Changes in blocking activity over the North Pacific Ocean and its possible relationship to sea surface temperature, EOS, transactions of the American Geophysical Union.

Professional Memberships:
American Geophysical Union
The Oceanography Society.

K. BUDGET

Budget for SEA Physical Oceanography and Marine Meteorology Program

Table 1: Budget summary for the Physical Oceanography and Marine Meteorology program components of the SEA program in FY94 and FY95. The budget for FY95 may change as information from the first year of the study is applied to refine the methodology. Chemical oceanographic, phytoplankton and zooplankton sampling appear as separately budgeted components of SEA.

Line Item	FY94	FY95
Personnel	112.28	198.25
Travel	3.80	12.00
Contractual	12.85	125.00
Commodities	11.00	15.00
Equipment	357.69	80.00
Total	497.62*	430.25
Indirect costs (Gen. Admin.)	33.58	84.06
Grand Total	531.20*	514.31*

* SEA-OCEAN 1994 Project Budget:

PWSSC portion:	$ 531,200
UAF portion:	126,110**
SEA-OCEAN Total	**$ 657,310**

** See attached page on Detailed Budget Form 3A and 3B for UAF detailed budget

EXXON VALDE[illegible]USTEE COUNCIL
1994 Federal Fis[illegible]ear Project Budget
October 1, 1993 - September 30, 1994

Project Description:

Sound Ecosystem Assessment, An Ecosystem Study of Prince William Sound Physical Oceanography (SEA-OCEAN); a descriptive physical oceanography of Prince William Sound and the Northern Gulf of Alaska

Budget Category:	1994 Project No. Authorized FFY 94	'94 Report/ '95 Interim* FFY 94	Remaining Cost** FFY 95	Total FFY 95	FFY 96	Comment
Personnel	$112.28	$ 59.34	$ 138.91	$ 198.25		* $85,846 of indirect costs are waived on equipment based upon ownership residing with PWSSC
Travel	3.80	1.59	10.41	12.00		
Contractual	12.85	20.00	105.00	125.00		** SEAOCEAN 1994 Project Budget
Commodities	11.0	0	15.00	15.00		PWSSC portion, $531,200
Equipment	357.69 *	10.00	70.00	80.00		UAF portion, $126,110***
Capital Outlay	0	0	0	0		SEAOCEAN Total, $657,310
Subtotal	497.62	90.93	339.32	430.25		
General Administration	33.58	19.42	64.64	84.06		*** see attached page for detailed UAF SEAOCEAN project budget
Project Total	531.20 **	110.35	403.96	514.31		
Full-time Equivalents (FTE)	- See Comment -					

Dollar amounts are shown in thousands of dollars.

Budget Year Proposed Personnel: Position Description	Reprt/Intrm Months	Reprt/Intrm Cost	Remaining Months	Remaining Cost
Physcial Oceanographer(Principal Investigator) 6.5mo @ $4584/mo	$38.74 K			
Marine Engineer 2.79 mo@ $7040./mo.	$25.54 K			
Technician 6 mo @ $3076/mo	$24.00 K			
Technician - 6 mo @ $3076/mo	$24.00 K			
Personnel Total	$112.28 K			

NEPA Cost:
*Oct 1, 1994 - Jan 31, 1995
**Feb 1, 1995 - Sep 30, 1995

07/14/93

1995

Printed: 3/23/94 6:02 PM

Project Number: 94320
Project Title: Sound Ecosystem Assessment
Sub-Project: PWS Physical Oceanography (SEA-OCEAN)
Agency: Prince William Sound Science Center, %University of Alaska Fairbanks

FORM 3A SUB-PROJECT DETAIL

EXXON VALDEZ TRUSTEE COUNCIL
1994 Federal Fiscal Year Project Budget
October 1, 1993 - September 30, 1994

Commodities:		Reprt/Intrm	Remaining
4 Mustang Suits @ $250 each	$1.00		
Floppy disks & accessories	1.00		
Statistical Software	3.00		
Analytical Software	2.50		
Communications Software	1.00		
Marine hardware accessories	1.00		
Wet Lab Supplies	1.00		
Paper & office supplies	0.50		
Total Commodities	$11.00		
	Commodities Total	$11.00	

Equipment:

150	kHz direct reading broad band Acoustic Doppler Current Profiler (ADCP)(vessel towed)	$64.20	1	Acoustic release and buoy floats, lines for ADCP	$15.09
1	ENDECO towing body	$19.00	1	Chelea Instruments CTD-F, CTD and Fluorimeter	$20.00
1	Towing cable	$8.00	1	Sea Bird SBE9plus underwater unit for 911plus CTD	$24.00
1	ENDECO paravane system	$7.00	1	SBE 11 plus deck unit	$5.00
1	EL-1000 transducer adapter	$4.00	1	Modem and PCB interface	$1.50
1	gyro interface	$4.50	1	SBE 32 Carousel	$14.50
1	Continental shelf broad band ADCP 150 kHz	$53.00	1	Adapter for 5 liter Niskin bottles	$0.40
1	Direct reading capability	$9.00	1	PVC Niskin bottles - 1.7liter @ $600. each	$7.20
1	Self contained end cap	$1.00	2	Sea Cat CTD's and enhancements @ $9.400. ea.	$18.80
1	Additiona 30 MB recording capacity	$3.00	2	Deep sea winches @$18K ea.	$36.00
1	additional battery pack	$7.50	3	Computers (486's) for shipboard data acquisition	$6.00
1	System Commissioning and ADCP training	$4.00	1	Fluorometer	$15.00
			1	Aandera current meter	$10.00
					$357.69
				Equipment Total	$357.69

Project Number: 94320
Project Title: Sound Ecosystem Assessment
Sub-Project: PWS Physical Oceanography (SEA-OCEAN)
Agency: Prince William Sound Science Center, %University of Alaska Fairbanks

FORM 3B
SUB-PROJECT DETAIL

Travel:		Reprt/Intrm	Remaining
1 r/t Cordova/Fairbanks @ 456 2 days per diem @ $140 6 air charter trips Cordova/Western Prince William Sound @ $500			
Total Travel	$3.8		
	Travel Total	3.8 K	

Contractual:			
Communications for real time data transmission and for communications between field personnel and Cordova	$5.00		
Shipping (~1%) and insurance (1%) for equipment	$6.40		
Telephone and facsimile	$0.95		
Copying	$0.50		
Total Contractual	$12.85		
	Contractual Total	$12.85	

Project Number:	94320
Project Title:	Sound Ecosystem Assessment
Sub-Project:	PWS Physical Oceanography (SEA-OCEAN)
Agency:	Prince William Sound Science Center, %University of Alaska Fairbanks

FORM 3B
SUB-PROJECT DETAIL

BUDGET SEAOCEAN
JOHNSON
1 April - 30 September 1994

	Mos.		
SALARIES AND BENEFITS			
Johnson, M.	1	$5,740	
Technician	2	$6,327	
M.S. Student	6	$7,279	
Benefits		$4,249	
TOTAL SALARIES AND BENEFITS			$23,594
SERVICES			
Vessel Charter (25 days @$1,400/day)		$35,000	
Lease - ADCP and Cable (2.9 mos. @$8,600/month)		$24,940	
Installation of thermosalinograph		$10,000	
Clerical/Secretarial Support (Academic Services @$35/hr)		$0	
Communications		$500	
TOTAL SERVICES			$70,440
TRAVEL			
2 R/T Cordova/Western Prince William Sound @$500		$1,000	
Per diem - 6 days @$125/day		$750	
4 R/T Fairbanks-Cordova @$465		$1,860	
TOTAL TRAVEL			$3,610
SUPPLIES			$744
TUITION			$2,500
TOTAL DIRECT COSTS			$100,888
INDIRECT COSTS (20% TOTAL PROJECT COSTS)			$25,222
TOTAL FUNDING REQUIRED			$126,110

94320N

#94320N

SFOS 94-143

RESEARCH PROPOSAL

946

TO: Mr. James Ayers, Executive Director
EVOS Trustees Council, Restoration Office
645 G Street, Anchorage Alaska 99501
(907) 276-8012, -7176 facsimile

FROM: Institute of Marine Science (IMS)
School of Fisheries and Ocean Sciences (SFOS)
University of Alaska Fairbanks (UAF)
Fairbanks, Alaska 99775-1080

and

Prince William Sound Science Center (Science Center)
P.O. Box 705, Cordova, Alaska 99574
(907) 424-5800, -5820 facsimile

TITLE: Sound Ecosystem Assessment (SEA)
Nearshore Fish (SEA-FISH)

PRINCIPAL INVESTIGATORS:

Dr. Donald Schell
Director, Institute of Marine Science
School of Fisheries & Ocean Sciences, University of Alaska Fairbanks (IMS/SFOS/UAF)

Dr. G.L. Thomas, President
Prince William Sound Science Center &
Affiliate Associate Professor, IMS/SFOS/UAF

NEW/CONTINUING: New

PROPOSED STARTING DATE: March 1, 1994

PROPOSED DURATION: Two years

AMOUNT REQUESTED: FY94 SEA-FISH - Total $ 591,400.
FY95 SEA-FISH - Total $ 652,939 .

Donald Schell — Date 4/13/94
Director, IMS/SFOS-UAF
(907) 474-7531

G.L. Thomas — Date
Principal Investigator
(907) 424-5800

A.V. Tyler — Date 4/18/94
Associate Dean, SFOS
(907) 474-6732

Ted DeLaca — Date 4/20/94
Director, Office of Arctic Research

Joan Osterkamp — Date 4-12 94
Executive Officer, SFOS
(907) 474-7824

G.L. Thomas — Date
President, PWS Science Center
(907) 424-5800

EXXON VALDEZ TRUSTEE COUNCIL
FY 94 DETAILED PROJECT DESCRIPTION

A. COVER PAGE

Project Title: Sound Ecosystem Assessment (SEA), An ecosystem research plan for Prince William Sound -- Nearshore Fish (SEA-FISH)

Project ID number: 94320 N

Project type: Research/Monitoring

Name of project leader(s): Dr. G.L. Thomas

Lead organization: Prince William Sound Science Center (PWSSC)

Cooperating agencies: University of Alaska Fairbanks (UAF)
Alaska Department of Fish and Game (ADF&G)
Prince William Sound Aquaculture Corporation (PWSAC)
Copper River Delta Institute, U.S. Forest Service (CRDI/USFS)
U.S. Fish and Wildlife Service (USF&WS)
National Biological Service (NBS)
Prince William Sound Oil Spill Recovery Institute (OSRI), National Oceanic & Atmospheric Administration (NOAA)

Cost of Project/FY 94: $ 591,400
Cost of Project/FY 95: $ 652,939
Cost of Project/FY 96 and beyond: $ 358,800 + equipment + inflation

Project start-up/completion dates: March 1, 1994 to Sept. 30, 1995 (for FY94)

Geographic Area of project: Prince William Sound & North Gulf of Alaska

Name of Project Leader: Dr. G.L. Thomas, Prince William Sound Science Center

Name of Project manager: Dr. Jerome Montague, Alaska Dept. of Fish & Game

B. INTRODUCTION

1. The Problem

Paleoclimatic, botanical and zoological records reveal that the earth has historically experienced both gradual and abrupt changes as a consequence of natural processes (Huntley 1992). Today, many changes are thought to be the consequence of human intervention into the natural processes. As we work to gain control over our unsustainable uses of natural resources, we must recognize that shifts in the physical and geochemical environment can confound our efforts to evaluate, manage, enhance and restore nature.

By accepting that ecology is dynamic and undergoing continuous change, to determine and mitigate for anthropogenic impacts, it is important that we know the direction and magnitude of natural change that is occurring (Holling 1978). The concept of restoring an ecosystem to the numbers or biomass state that existed prior to a major anthropogenic event is ecologically unsound (Raven 1993). To address sustainability without implementing massive preservation practices, we must develop a better understanding of how the trophic structure responds to natural processes (GLOBEC 1991A).

All animals in the sea are affected by the physics and chemistry of the water (Russel-Hunter 1976). The Sound Ecosystem Assessment Dynamics program, SEA, focuses on how the trophic structure that supports pink salmon and Pacific herring in Prince William Sound responds to climate forcing (SEA 1993). It is recognized that this trophic structure supports many other fish, bird and mammal populations of interest to the Exxon Valdez Oil Spill (EVOS) Trustee Council. The SEA program studies on the interactions between key organisms and their physical and biological environments are the first steps to improving our understanding of the Prince William Sound (PWS) ecosystem.

2. The approach

SEA will be implemented by three interdisciplinary efforts: (1) large and fine scale, field studies on physical oceanography and plankton/nekton ecology, (2) applications and development of new technologies, and (3) mathematical modeling. The application of acoustic and optical technologies in the large and fine scale field studies, and the mathematical modeling are included in three of four proposals submitted by the PWS Science Center (SEAOCEAN, SEAFISH, SEADATA). SEAOCEAN and SEAFISH support several agency and university projects that address plankton, fish, bird and mammal problems. SEADATA supports: (1) the reduction and integration of quasicontinuous acoustic and optical data with discrete samples, (2) the modeling of physical and biological mechanisms, (3) analytical evaluations of new technologies, and (4) data simulation into the SEA model, which will provide other Principal Investigators working on complementary SEA projects large scale synoptic data on the physical and biological environment. The continuation of the SEA program planning is included in a fourth proposal submitted by the PWS Science Center (SEAPLAN).

3. Justification

In 1993, the unexpected run failures of wild and hatchery pink salmon and Pacific herring (Funk 1993; SEA 1993) underscored the need to gain a more comprehensive understanding of how the fish populations are influenced by natural and anthropogenic perturbations in Prince William Sound (PWS). Responding to the outcry by commercial fishers and the communities of Prince William Sound, the Trustee Council funded the development a plan, Sound Ecosystem Assessment (SEA), to focus on the PWS fisheries ecosystem (SEA 1993).

The fisheries ecosystem that the SEA plan proposes to study is the nearshore and pelagic habitats along the migratory routes of juvenile pink salmon and herring in PWS (SEA 1993). New knowledge of the interacting predator, competitor and prey resources and the physical processes that limit production are expected to explain much of the variability in the recruitment of pink salmon and Pacific herring (Pearcy 1992).

The anthropogenic factor that is of paramount interest is the impact of the EXXON VALDEZ oil spill (Wolfe et al. 1993). Oiled animals cannot move or feed normally, and crude oil can alter physiology and genetics of individual organisms. Because the oil exposure and ingestion can affect prey, competitors and predators of pink salmon and herring, knowledge of the trophic structure is essential to determine impact. The number of possible prey, competitor and predator species, critical habitats and conditions suggest there are many mechanisms that operate simultaneously which contribute to oil spill impact (Holling 1978).

Confounding the cumulative impact of oil on PWS pink salmon and herring are other anthropogenic events (commercial fishing mortality and fish hatchery supplementation) and large natural fluctuations in marine productivity (Thomas and Mathisen 1993). Commercial fisheries have operated in PWS for over a century and hatcheries have been in operation for the last two decades. Because oil effects operate simultaneously with the other anthropogenic and natural effects, the impacts may not have to be immediate or continuous, but can appear abruptly, and sometimes long after the event (Holling 1978). Also, if the trophic structure or habitat was changed substantially by an event, shifts in the ecosystem productivity could result in something different from the original conditions (Westman 1985).

Holling (1978) states that it is unreasonable to measure all organisms within the ecosystem and suggested, "The parts of an ecological system are connected to each other in a selective way that has implication for what should be measured." Not everything in the ecosystem is strongly connected so unless there is good intuition that a causal mechanism between populations exists, linkages may never be found by statistical approaches or, those approaches may result in erroneous linkages (Green 1979). The SEA program has focused on hypothetical mechanisms that affect the pink salmon and Pacific herring, and their prey, competitors' and predators' growth and survival along their migratory route in the Sound.

4. The SEA model

Present single species population dynamic models are inadequate to predict animal abundance for management or conservation purposes (Cullen 1988). Models without trophic structure have limited use in the assessment of environmental impacts (Holling 1978). Since

major changes and substitutions of species can take place within a trophic structure that maintains the same function or role, while changing the productivity of the system, measurement of ecosystem structure is important (Holling 1978). The development of the SEA model will provide a more robust approach to evaluating the resiliency and reversibility (Westman 1985) of ecosystem impacts because it incorporates ocean and trophic state conditions in a mechanistic structure. Therefore, the causation for changes in abundance can be evaluated.

The SEA model was built upon a foundation of past research and monitoring conducted by researchers from universities and agencies. Like GLOBEC (1991a), this understanding and the assimilation of new data from acoustical and optical measurement technologies will be used to develop a first generation, PWS ecosystem model. Since the pink salmon and Pacific herring are dominant PWS fish populations, when combined with their co-occurring species, they are expected to represent a major portion of the pelagic productivity of the Sound's ecosystem (SEA 1993). Once developed, the SEA model will be used for nowcasting[1] and short term forecasting of pink salmon and Pacific herring recruitment.

5. The SEA hypotheses

To understand anthropogenic or natural effects on the production of pink salmon and herring, SEA developed several hypotheses. The primary hypotheses of the SEA program concerns flushing of prey from the Sound (the river-lake hypothesis) and the switching by predators to larval fish when the macrozooplanktors are not abundant (the prey switching hypothesis). These are coupled hypotheses because when the flushing of PWS is high, the macrozooplankton prey is low, which causes larval and juvenile fish predation to be high. Since flushing is positively correlated with storms, and stormy years are cold years, the physical growth conditions (temperature and currents) are also poor when there is limited prey.

Many researchers have proposed that multiannual, climate-driven cycles of three, five, seven, 14, 18.6 years have a dominant influence on marine productivity and fish recruitment (Trenberth 1990; Royer 1989, 1993; Salmon 1992; Thomas and Mathisen 1993). Shifts in predator populations as a response to climatic events have also been shown to have pronounced impacts on key marine fish populations. Given the likelihood that natural, climate-driven cycles have a dominant influence on marine fish recruitment, the testing of the river-lake and prey-switching hypotheses as climate-driven mechanisms are prerequisites for impact assessment of oil, fishing and hatcheries.

6. The SEA field measurement program

Synoptic sampling of both the biological and physical characteristics of the water column and samplers that operate on quasi-continuous, spatial and temporal scales are essential if SEA is to link small scale process measurements to population and ecosystem parameters (Thomas 1992, GLOBEC 1991b). In response to this, the three core SEA projects, SEAOCEAN, SEAFISH and SEADATA incorporate the necessary acoustical, optical,

[1]Nowcasting is the process of monitoring measurable variables (temperature, predator density, prey density) to predict in real time an unmeasureable variable such as fish survival.

measurement and computer intensive analytical and communication tools. Recognizing the rapid evolution of technologies, a small component of each SEA project will be the research and development of new hardware and software.

The SEA field program will utilize the conceptual experimental design of GLOBEC (1991c), which involves the nesting of fine scale measurement programs within large scale ecosystem monitoring efforts. Ocean state and prey monitoring will require large scale surveys in the: (1) eastern Sound, (2) western Sound, and (3) coastal buoyancy current, and fine scale studies in the: (4) Hinchinbrook Entrance, and (5) Montague Straits (Figure 1). Monitoring will require large scale and fine scale surveys in the western Sound, which is the primary migration route of pink salmon and Pacific herring.

7. Nearshore Fish - SEA-FISH

Although there are some long term databases on the commercially harvested fish populations, little is known about the plankton/nekton assemblage that resides in the Sound. Studies by Cooney (1986, 1987, 1993) have shown that the large oceanic calanoids and sometimes neritic harpacticoid copepods are the critical food sources for larval and juvenile fishes, but the euphausids which often form dense midwater layers throughout the Sound are an unknown quantity. Also, work by the Alaska Department of Fish and Game has shown that pink salmon and Pacific herring are dominant populations in the Sound, but sandlance, smelt and gadoid populations potentially represent even larger biomasses. Thus, at least along the migratory routes, SEAFISH needs to identify the dominant plankton and nekton, as well as assess their abundance, distribution and size to be able to address the SEA hypotheses.

SEAFISH will use underwater acoustics and optics, and aerial optics to map distributions and assess biomass of the fish and plankton assemblage in the Sound. Acoustic and optical targets will be subsampled with a variety of nets and optics to collect biological information. Underwater acoustic sampling will be conducted on both large and fine scales. Aerial optics will be used exclusively for large scale sampling.

Large scale sampling will define potential prey and predator fields along the pink salmon migratory route and in the juvenile Pacific herring rearing areas. This information will be collected simultaneously with the physical and biological oceanography to evaluate specific climate-driven hypotheses. The fine scale sampling will define the distribution and biomass of predators and prey, while tracking the migrating pink salmon. In most cases, acoustic information will be used to direct the net fishing efforts for biological information.

8. Expansion of SEA

SEA researchers have already developed cooperative sampling designs with Alaska Department of Fish and Game on sockeye salmon and harbor seals, the U.S. Fish and Wildlife Service on marble murrelets, pigeon guillemots, and kittiwakes, and the Copper River Delta Institute/U.S. Forest Service on gulls, sea ducks and shorebirds. Cooperative sampling with researchers on killer and humpback whales is pending and we are seeking an agreement with NOAA on forage and groundfish assessments. Ultimately, we see listing the

marine and terrestrial subsystems in the PWS comprehensive ecosystem model.

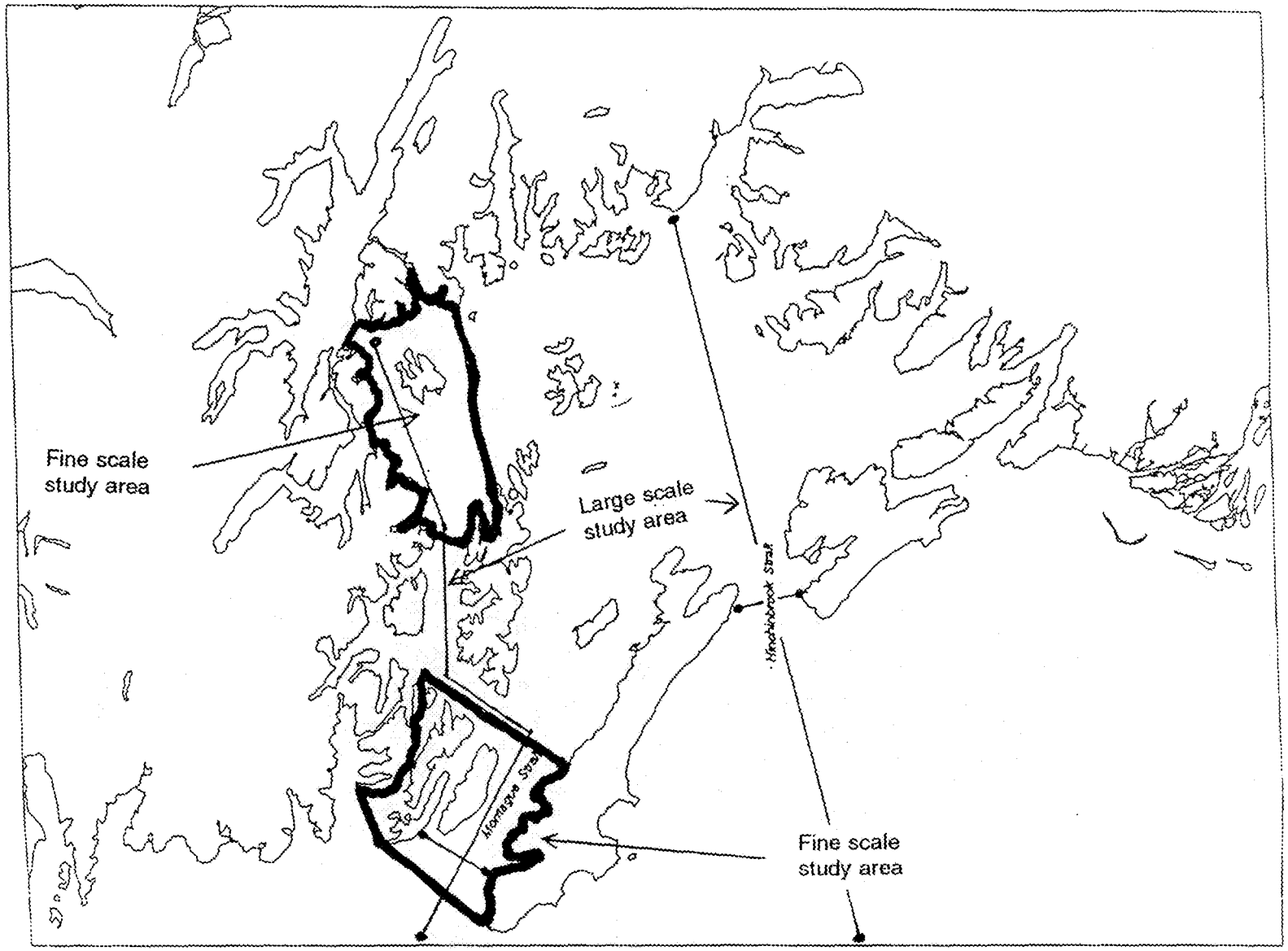

Figure 1: Large scale and fine scale study areas in Prince William Sound.

9. SEA Goals

The central scientific goals of SEA are: (1) to increase understanding of processes that determine the abundance of key animal populations in the Sound, initially pink salmon and Pacific herring have been chosen, (2) to develop and apply new methods and technologies for evaluating life history parameters of key marine populations important to evaluating the key species, and (3) to acquire the ability to predict how the abundance of key animal populations change.

Achieving these goals will ultimately address scientific and public concerns about the health of this valuable Alaskan coastal environment. Benefits will be first evidenced by having scientists and fishermen work together in the field, which will build public trust in scientific methods. This trust has waned in the aftermath of the spill. Second, ongoing, local, public education and outreach programs will be enhanced by having a comprehensive, locally available, scientific data base on the status of PWS resources. In addition, the availability of new information and technologies to acquire better information will allow improved harvest management strategies to be developed. Ultimately, better forecasts of fish production and improved predictions of fisheries responses to natural and anthropogenic perturbations will allow a policy of sustainability to be established. Sustainability is the insurance that local communities of the Sound need to protect their standard of living.

10. The next decade

Understanding the effects of climate change on the trophic structure that supports pink salmon and Pacific herring populations in the Sound will require multidisciplinary and multiorganizational effort. We can't ignore the processes any longer because the economies and life styles of the people in the Sound depend on assessment of these relationships. The SEA program will bring new ideas, instruments, and insights to scientists working to improve our recognition of ecosystem processes.

C. PROJECT DESCRIPTION

Knowledge of the effects of toxic chemicals on individual organisms is extremely useful to characterize the qualitative nature of impact that occurs with the introduction of a toxicant into the environment. However, to determine the quantitative impacts, an understanding of ecosystem-level interactions is essential. Westman (1985) presented four approaches that are used to study ecosystem level impact. They are listed here by the strength of the scientific method and logistic difficulty: (1) in situ, experimental manipulations of the natural ecosystem, (2) in situ, synecological studies of natural ecosystems along disturbance gradients, (3) in vivo, microcosm studies, and (4) in vitro, data assimilation into computer models of natural ecosystems, which can be subjected to disturbance by simulations.

The SEA program is offered a unique opportunity to take an ecosystem manipulation approach because of the operations of the PWS hatcheries, which release over 700 million salmon fry annually. Pilot field studies of predator response to hatchery releases were conducted using underwater acoustics at the Sawmill Bay, Esther and Cannery Creek

facilities in 1992 and 1993. Therefore, the initial implementation of the SEA program will use hatchery releases as the experimental manipulation of the trophic structure supporting pink salmon. Synecological studies of the ecosystem along natural gradients and data assimilation into computer models are the approach that will be taken with both pink salmon and Pacific herring.

SEA's conceptual framework is similar to GLOBEC (1991c). The PWS pink salmon and herring populations fluctuate in abundance as the cumulative result of three processes: birth, mortality and transport. A simplified description of the population growth rate is:

$$dN/dt = Birth\ rate - Death - Immigration + Emigration$$

where,

- *Birth* is influenced by the numbers and condition of the parents and the environment at spawning,

- *Death* is influenced by the condition of the eggs or fish and the environment, which is primarily a function of growth and predator densities,

- growth = Consumption - (Respiration + Waste Losses), which are functions of food quantity and quality, competition, and condition of the fish and environment.

- *Immigration* is the transport (advection) or straying of fish (diffusion) into the population, which is primarily a function of the physical environment and the behavior of the fish,

- *Emigration* is the transport or straying of fish out of the population, which is primarily a function of the physical environment and the behavior of the fish.

The importance of general ocean state and the condition of the fish (population state) is emphasized since physical and physiology/behavior conditions affect each variable and their subvariables in time and space. The importance of trophic state is emphasized fewer times above, but can be dominant processes in the *dN/dt*. To understand the local rate of change in any pelagic population one must reliably quantify these processes. This is what SEA plans to accomplish and why large and fine scale nested surveys and new technologies are essential.

1. Resources and Associated Services:

The history of communities within Prince William Sound is closely linked, culturally, and economically, with the use of marine resources (Thomas et al. 1991). In particular, pink salmon and herring have historically supported the largest commercial fisheries in the region. These species are critically important to subsistence and recreational users of fishery resources in the Sound. They also provide a food source for many species of fish, birds, and mammals.

According to the EVOS Draft '94 Work Plan, pink salmon and herring currently show no sign

of recovery nearly five years after the oil spill. Commercial, subsistence and sport users in Cordova, Valdez, Whittier, Tatitlek, Chenega, Anchorage and other communities inside and outside Alaska depend on these resources and associated services. The depressed condition of these resources continues to effect the social and economic health of the resource users and communities in the Sound, and in the eyes of the public diminishes the value of these resources to levels below those that existed before the spill.

The Nearshore Fish project (SEAFISH) is an integral part of the SEA program. It will provide ecosystem level information, specifically on prey and predator abundance that influences the survival of pink salmon and Pacific herring populations in Prince William Sound. The SEAFISH information will assist the EVOS Trustee Council in planning future restoration efforts for these resources and associated services.

2. Relation to Other Damage Assessment/Restoration Work

Although designed around the dynamics of pink salmon and Pacific herring, the ecosystem approach of Nearshore Fish will result in information about the restoration of other injured resources throughout the oil spill area. SEAFISH will provide a better understanding of processes regulating the size of the pink salmon and herring spawning populations available to apex predators such as birds, marine and terrestrial mammals, and humans.

Initial collaborations in 1994 and further planning for work to be implemented beginning in 1995 will focus on expanding SEAFISH to address the roles of sea birds, marine mammals, and ecotoxicological factors in the marine system. Work has already begun to build connections with ongoing projects in these areas. The sampling design, technology and modeling efforts used in this study of Prince William Sound should also be transferable to other parts of the spill area, especially for sea birds and mammals.

3. Objectives

SEAFISH will provide large and fine scale trophic structure information to the SEA model where it will be integrated with ocean state and pink salmon or Pacific herring information. New information emerging from SEAFISH will contribute to a comprehensive data base for the fisheries of Prince William Sound. This information will serve the needs of the region for more informed management, enhancement, and mandated restoration activities. As a project within the multidisciplinary, integrated SEA program, SEAFISH will achieve the following objectives:

(1) Describe the macrozooplankton prey resource distribution and biomass in real time for allocation of net sampling. Combined with the catch and oceanographic data, this will be used to evaluate the river-lake hypotheses and availability of food for juvenile pink salmon and Pacific herring.

(2) Describe the fish predator distribution and biomass in real time for allocation of net sampling. Combined with the catch, macrozooplankton and oceanographic data, this

will be used to evaluate the prey switching hypothesis.

(3) In collaboration with other EVOS researchers, integrate the SEAFISH research project with research on sea birds, mammals, other fishes, terrestrial ecology and ecotoxicology.

(4) Determine the relative recruitment of juvenile Pacific herring into the nearshore rearing areas and adult spawning population of PWS.

4. Methods

SEAFISH is a multidisciplinary study that will rely on: (1) cooperative, model development to assist in sampling design, data analysis and interpretation, (2) shared vessel and facilities for data collection and logistical support, (3) data sharing with the agency and university principal investigators, and (3) remote sensing with acoustical and optical technologies (Table 1). SEAFISH will rely heavily on the existing knowledge and skills of commercial fishers to prestratify surveys to areas preferred by the fishes, and for the capture fishes that are observed acoustically. Salmon hatcheries in the region will provide support for SEAFISH field crews and the hatchery releases of pink salmon will be treated as experimental manipulation of the nearshore Sound ecosystem.

The following methods will be used to address the specific objectives.

Objective 1 - macrozooplankton

The large scale distribution and information on density of the macrozooplankton will be measured using a high frequency scientific echosounder (HFSE), a 150 kHz acoustic doppler current profiler (ADCP) and an optical plankton counter (OPC). Initially, the program will use a 420 kHz dual beam or digital HFSE for macrozooplankton assessment, with 720 kHz as potential alternate. The BioSonics ESP software will be used to integrate the acoustic backscatter. Interactive Data Language (IDL) and Advanced Visual Systems (AVS) code will be developed on a workstation for visualization. The HFSE system will be deployed from the trawler and work the large scale western Sound transects.

Although developed for its current measuring capability, the ADCP backscatter has been used extensively to assess macrozooplankton distribution and density. The oceanographic project will deploy a towed ADCP system on the oceanography charter that transects the coastal buoyancy current, eastern Sound, western Sound, Hinchinbrook Entrance and Montague Straights (Salmon personal communication). This sampling will be paired with OPC, aquashuttle measurements to evaluate the use of this information for macrozooplankton assessment. On the western Sound transects, the 420 kHz HRSE measurements will be paired with the 150 kHz ADCP backscatter.

By arrangement, the ADF&G is providing the charter vessels and the OPC (Dana Schmidt). The information and modeling project specify the calibration and field engineering of the OPC system that will be mounted on an Aquashuttle towed vehicle (Patrick personal

communication). The aquashuttle yo-yo's through the water column as it is towed by a vessel. By mounting the OPC on the shuttle, vertical distribution information on the size of macrozooplankton is obtained.

By arrangement, the University of Alaska Fairbanks researchers will provide the Bongo, rectangular midwater trawl (RMT) and vertical plankton nets and personnel to sample macrozooplankton. ADF&G and UAF will share responsibility to process zooplankton samples. The quasicontinuous, acoustical and optical information on the density of plankton will be used to direct net sampling and be shared among the individual researchers in the program.

Measurements of mesoscale and fine scale oceanographic features and trophic structure are essential for the thorough characterization of environmental conditions that constrain the growth and survival of pink salmon and Pacific herring in the Sound. In 1994, this effort will be concentrated in the western Sound; starting the sampling in April at the Esther hatchery, and ending the sampling in July at Montague Straits. The southward movement of the fine scale sampling is based upon a simulation of the spatial and temporal outmigration of pink salmon juveniles.

Simultaneous sampling with multibeam acoustics of plankton and nekton will be made to elucidate the fine scale physical and biological structure (e.g., thermocline, pycnocline, fronts, eddies, shear zones, plankton and fish aggregations). Water temperature, salinity, and turbidity will be measured simultaneous with the acoustic measurements. All data streams will be geotime coded using a global positioning system (GPS). The acoustics, water quality, navigational, and time data will be integrated through a graphical user interface, and data will be digitized and stored in the field on magnetic medium. Postsurvey processing of acoustic data will be conducted at the Science Center (Patrick personal communication).

As in the large scale sampling, subsampling and processing of plankton and fish catch data will be the responsibility of the University of Alaska Fairbanks (Cooney personal communication) and ADF&G (Willette personal communication), respectively.

Objective 2 - nekton

Large scale measurements of fish distributions will be made using BioSonics and Simrad 120 kHz dual or split beam HFSE, which may be supplemented with 38 kHz measurements. Initially, the program will use a 120 kHz dual beam, digital or split beam HFSE for fish assessment, with 38 kHz as potential alternate. The BioSonics ESP or Simrad ES software will be used to determine target strengths and integrate the acoustic backscatter. IDL and AVS code will be developed on a workstation for visualization. HFSE systems will be deployed from the trawler on the western Sound transects, and on two acoustic survey boats in the fine scale western Sound study areas.

By arrangement, the ADF&G is providing the charter vessels, nets and is responsible for processing catch information. The charters will be required to be equipped with search light sonars (typically Westmar manufacture). Operation of these sonars along acoustic transect lines allows for increased area swept along the transect line sampled by the scientific

echosounder. Although this is a qualitative process, it is the only way to evaluate the contagiousness of fish schools in the study areas. In 1995, we plan to deploy a Simrad SD 570 electronic sector scanning sonar with the intent to develop a quantitative procedure to combine sector scanning and echosounding for fish stock assessment.

In 1994, a compact, airborne, spectral imager (CASI) or blue green laser (LIDAR) will be used systematically to map the distribution of fish schools along the western corridor of the Sound. This will be done in conjunction with the acoustic surveys to evaluate the capability of the aerial surveys to map large scale distributions of fish.

For the fine scale studies that track outmigrating pink salmon fry as they are released from the hatcheries, ADF&G is also providing two purse seiners, nets adequate to catch the smaller predators (100-200mm), and the crew to sample the net catches for biological information. In 1994, this effort will be concentrated in the western Sound; sampling will start in April at the Esther hatchery and end in July at Montague Straits. The southward movement of the fine scale sampling is based upon a simulation of the spatial and temporal outmigration of pink salmon juveniles.

Simultaneous sampling of plankton and nekton will be made with multibeam acoustics and nets to elucidate the fine scale physical and biological structure (e.g., thermocline, pycnocline, fronts, eddies, shear zones, plankton and fish aggregations). An ADCP will occasionally be deployed aboard the seiner or a small skiff for nearshore work particularly to characterize velocity fields of small scale frontal structures and nearshore tidal rips (Salmon personal communication). Water temperature, salinity, and turbidity will be measured simultaneous with the acoustic measurements. All data streams will be geotime coded using a global positioning system (GPS). The acoustics, water quality, navigational, and time data will be integrated using a graphical user interface, and data will be digitized and stored in the field on magnetic medium. Postsurvey processing of acoustic data will be conducted at the Science Center (Patrick personal communication).

Diel, tidal, weather, and seasonal patterns will be used to stratify sampling into comparable time windows. In the fine scale sample areas, a two-boat survey design (Thomas et al. 1978) will be used to assess zooplankton and fish. The first boat is used to conduct acoustic transects, while the second follows and samples fish targets observed by the first boat. Data will be recorded at both speeds, and the actual speed of transecting will be analytically determined for different nekton distributions.

A combination of side and downlooking sonar will be used to track juvenile pink salmon as they migrate southward along the shoreline of PWS. Visual observation and mini purse seining will be used to subsample the pink salmon for growth, feeding and tag recovery information. Subsampling will be the responsibility of ADF&G (Willette personal communication).

Although developed for its current and zooplankton measuring capability, the 150 kHz ADCP backscatter can be used to assess fish densities and distribution (David Salmon, personal communication). This will be evaluated on the oceanography charter that transects the coastal buoyancy current, eastern Sound, western Sound, Hinchinbrook Entrance and

Montague Straits (Salmon personal communication). This sampling will be paired with the 120 kHz multibeam system on the western Sound trawler to evaluate the use of this information for fish assessment.

Objective 3 - birds, mammals, other fish

SEAFISH will collaborate with other EVOS researchers and integrate with research on sea birds, mammals, and other fishes. The large scale distribution and information on density of the macrozooplankton and fishes, and oceanographic data (current velocities and temperature), will provide valuable information to bird and mammal researchers. Bird and mammal observers will use visual, photographic, and video measurement techniques on the western Sound vessel and aerial transects. The USFWS will provide 2 observers and a 27 ft. Boston Whaler to serve as one of the acoustic survey vessels (David Irons personal communication).

Compact, airborne, spectrographic, imager (CASI), video and/or photographic techniques will be deployed to survey for events that create the formation of large patches of plankton, fish, bird and mammal concentrations. This surveying effort will be linked with the large scale distribution of mesoscale features in the Sound, particularly tidal rips and shear zones. It will be designed to test the tidal shuffle hypotheses, where large plankton/nekton/apex predator populations aggregate in cyclic fashion at specific locations due to tidal current velocities and shoreline or bottom morphology.

The aerial surveys and possibly satellite images (Eslinger personal communication) will be used to facilitate event driven sampling of physical and biological features (such as fronts, tidal rips and associated animals) that are visible from the air (with either a visible or thermal signature). These surveys will be conducted with small float planes along the western Sound migratory routes equipped with optical sensor systems. Data will be GPS linked, collected and processed by Science Center personnel (Scheel, personal communication). Qualitative records of events will be made available to all SEA investigators during or immediately after the flights.

By arrangement, USFWS, ADF&G, NOAA, UAF and the Science Center will develop a proposal to expand the SEA-FISH program to complement the forage fish project. There are also specific projects which routinely conduct surveys and overflights of the region, such as the Coghill Lake Sockeye salmon enhancement project, the marine mammal census by the National Marine Fisheries Service (NMFS) and independent scientists, and bird and mammal population surveys being conducted by the USFWS. We will pursue cooperation with other entities by subcontract where ever opportunities for sharing field logistics are cost efficient.

Objective 4 - Pacific herring nursery areas

The information on Pacific herring recruitment suggest that events in the juvenile nursery area of the Sound could influence recruitment into the adult population. Nearshore surveys to determine overwinter stock density and co-occurring species will use the two-boat survey method described under objective 2 - nekton assessment. Because of the unknown distribution of Pacific herring juveniles, only reconnaissance surveys are planned in 1994.

Integration of Large and Small Scale Measurements

The migratory pathway that the salmon utilize during their outmigration from the Sound will be characterized in terms of its physical and biological structure. Whether these animals respond to general or specific physical and biological conditions during their outmigration will be addressed. This will be accomplished through the integration of large and small scale horizontal and vertical measurements made in western PWS.

SEAFISH will generate large amounts of data due to the length of the field season and the nature of the measurement instrumentation. The management of the data is budgeted under a separate program (SEADATA - Information Systems and Modeling) that will integrate the data collected in all SEA programs (Patrick personal communication). Under this task, the large and small scale physical, chemical and biological data will be assimilated into numerical models. This task is critical to the success of the SEA as well as SEAFISH.

The approach taken here is non traditional in that all data management is usually budgeted for within each component of a research program. In SEA, large scale data are collected for all researchers as a service to integrate their fine scale programs with the surrounding ecosystem. Having the large scale data analyzed in this fashion should minimize the time necessary for the reporting of more complex information. The integration of data sets may also allow for several fine scale data sets to be online and accessible. The integrated interdisciplinary, interorganizational nature of SEA and the scale of sampling require that an information management and modeling effort be conducted to maintain communication between parties and the scientific community.

The acoustical, physical, spatial and temporal data will be collected simultaneously and integrated utilizing a navigational track plotter and graphic user interface. Most equipment are operated and data are logged by software from a 486, personal computer. Most data will be stored on optical or magnetic disks, displayed in real time on a color printer, and some data will be processed in real time. Preprocessing of the data will be with BioSonics and Simrad software, which provides echograms, electronic maps of track lines, in-situ target strength, echo integration and counting capabilities. After the data are appropriately scaled, they will be transferred to the Science Center's geographic information system (GIS) and stored in the appropriate format for post processing (ARCINFO, IDL, AVS). The Center's GIS mapping, visualization and analytical software will be run on Sun workstations.

Post processing of echo-counting, echo-integration, target strength determination, patch size determination, and biomass estimation will be done in accordance to standard techniques (Traynor and Erenberg 1988, Thorne 1981, etc.). Acoustic, physical, ground truth, and seasonal measurements will be used to develop discriminate functions for patch identification (Rose 1991). GIS will be used to map and overlay nekton patches and physical conditions to develop specific hypotheses about their relationship.

Initial simulation modeling of pink salmon and herring populations in Prince William Sound will include assessments of ocean state, plankton dynamics, predators and prey abundance and size. The short term objective of the modeling will be to nowcasting and to make short

term forecasts. Sensitivity and risk analysis approaches will be used to prioritize tasks, such as choice of sampling protocols to resolve biological and physical questions.

Regional database

A data base and archival/retrieval system will be developed so that the results of SEA are accessible to the agencies responsible for restoration in Prince William Sound. This system will be a tool for improving resource harvest strategies, forecasting, management, enhancement and education in the spill-impacted area.

A necessary component of this database will be interaction with or creation of a database of pertinent historical information (pre and post spill) already available on the ecosystem, with particular attention to EVOS-related research. Geographic visualizations and analyses, data listings, reports, and other services will be available as part of the SEA data base and management system. Predictive and "what if" scenario modeling tools, computer, communication, and library facilities will be available to assist in conducting SEA programs and to aid in restoration design and implementation, and resource management.

Integration with other studies

Since the selection of dominant species as key populations (Pacific herring and pink salmon) in Prince William Sound is a way to best represent the pelagic-nearshore ecosystem, it allows for successful integration with many of the ongoing apex predator studies in the region, regardless of oil-spill relationship. Nearly all pelagic-nearshore, apex predator populations are subject to the same ocean state conditions and dependent upon the dominant species, and/or the prey and predator populations that are monitored on the large scale. Thus, whether bird or mammal, the integration of apex predator studies with SEA is the efficient and most meaningful approach to improving ecological studies in the region.

There are no sharp boundaries between the pelagic-nearshore, intertidal ecosystems and the marine and terrestrial ecosystems. They are linked by the transfer of carbon and nutrients via the migrations of animal populations that feed on marine production. There are exciting areas of future cooperation and an expanded ecosystem studies program that can lead to a link of the SEA program with terrestrial resource ecosystem evaluations (TREE), or SEA TREE.

Table 1: Acoustic and target sampling vessel, equipment and personnel for SEA Program in 1994

Vessel	Activity	Equipment	Personnel
Trawler	Ocean State Plankton Dynamics Juv. Salmon Predators	CTD*, Doppler Nets, Water Bottles Acoustics (2 frequencies for plankton/nekton), Mid-water Trawl CTD winch & boom	1 Phys. Oceanographer 1 Biol. Oceanographer 1 Acoustic Technician 1 Fish Biologist 1 Marine Bird/Mammal Observer
Seiner #1	Ocean State Plankton Dynamics Juv. Salmon Predators	CTD Ring net Acoustics, Seines/Gillnets	1 Oceanographer Tech. 2 Fish biologists
Acoustic #1	Fish Birds Mammals	Acoustics	1 Boat driver 1 Bird/Mammal Obs. 1 Acoustician
Seiner #2	Ocean State Plankton Dynamics Juv. Salmon Predators	CTD Ring net Acoustics, Seines/Gillnets	1 Oceanographer Tech. 2 Fish biologists
Acoustic #2	Fish Birds Mammals	Acoustics	1 Boat driver 1 Bird/Mammal Obs. 1 Acoustician
Phys. Ocn. Vessel	Currents Plankton Dynamics	CTD, Water Bottles Nets	1 Phys. Oceanographer 2 Biol. Oceanographers

*CTD - Conductivity Temperature Depth

5. Location

This project will be conducted within the EVOS impacted area in Prince William Sound and the waters immediately adjacent to this region. Prince William Sound is an ideal location for such a long term ecosystem study. The Sound is a semi enclosed basin, of tractable size, and suitable for sampling with small vessels. Because of fundamental similarities in the structure of northern pelagic ecosystems and the unexplained declines in seabirds and marine mammals in the north Pacific, an ecosystem study for Prince William Sound could serve as a model for understanding the ecosystem dynamics in other areas.

Siting of the SEA program in Cordova is both efficient and practical since the logistics of travel and freight are enhanced by daily jet service. Of critical importance is the easy access to the Sound on a year around basis from the protected Orca Inlet, Cordova. These logistics explain some of the reasons all of the following entities chosen to locate in Cordova: a major fishing fleet, the Alaska Department of Fish and Game, the U.S. Forest Service, the Copper River Delta Institute, the Prince William Sound Science Center, the Prince William Sound Aquaculture Corporation, the Hazardous Substance Spill Technology Review Council, and the Prince William Sound Oil Spill Recovery Institute. Cordova also serves PWS with an educational outreach program that ties the people and communities together.

6. Technical Support

The SEA science community is interdisciplinary and unique to the Trustee process in that it involves collaboration between nonprofit research organizations (the University of Alaska Fairbanks, PWS Science Center, PWS Aquaculture Corporation) and government agencies.

The Science Center has put together a multidipisciplinary team of scientists from several universities who are well versed in acoustical and optical technologies, physical and biological oceanography, quantitative aquatic ecology, population dynamics and mathematical modeling. Through their combined experience in aquatic research, the Center's science network brings expertise from throughout North America. This integration of technology and science is critical to effectively studying and understanding the structure and dynamics of the Sound ecosystem. Establishment of a coherent approach for SEA issues, especially to quantify the physical environment and its relation to the distribution of organisms in the Sound, will require the best measurement and analytical technologies.

Technical support for the acoustics will be supervised by Dr. G.L. Thomas. Robert DeCino, staff biologist, has conducted acoustic surveys at the PWSAC hatcheries, overwintering Pacific herring and Coghill Lake sockeye salmon. Jay Kirsch, electrical engineer, has been with the Chesapeake Bay Biological Station and writes IDL and AVS code for processing acoustic data on workstations. Dr. Vince Patrick, mathematician/physicist, is affiliated with the Advanced Visualization Laboratory at the University of Maryland and is an expert in modeling, data visualization and assimilation.

7. Contracts

Consultants will be used for technical support where it is appropriate.

8. Future planning

In addition to the SEA concepts, the PWS bioregional planning effort received overwhelmingly support from outside reviewers at the December 1993 workshop held in Cordova. It was recognized that the implementation of SEA as a large scale, long term ecosystem research program will require continual planning by local organizations and communities. This bioregional effort is proposed as the planning project, SEAPLAN.

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D. SCHEDULE

SEA hypothesizes that recruitment success of pink salmon and herring populations is related to losses due to physical processes and to predation during early life stages that occur within the Sound (SEA 1993). These hypotheses provide a means to focus the field efforts on those parts of the ecosystem that support these critical life stages. Thus, the juvenile Pacific herring and pink salmon rearing environments define the primary areas of study (Figure 1). The migration route and timing of pink salmon juveniles out of the Sound and release of fry from the hatcheries is well known. For Pacific herring, this is not the case so some basic work will be needed to determine the juveniles movement into nearshore rearing areas.

1. Biological timing

Previous studies of the Sound indicate that the important early portions of the marine production cycle are tightly compressed in time around the months of April and May (Cooney 1986). During this period, massive, upper layer, stocks of large zooplankton arise from the deeper water to graze on a short-lived diatom bloom. Herring spawning and both the wild and hatchery-reared pink salmon outmigration occurs at this time as well. SEA hypothesizes that the success or failure of a pink salmon depends on ecosystem level conditions at this time. Again, this picture is not as clear for Pacific herring whom migrate to the nearshore areas and rear for several years before recruiting into the adult population.

The principal sampling period will occur from April through July (Tables 2 and 3), although measurements will also be made in the nearshore areas of PWS in the fall and winter months to answer questions relevant to the overwintering Pacific herring growth and survival and ambient salmon predator densities. The months of April and May will be sampled most intensively since the correlations observed between zooplankton abundance and atmospheric forcing are strongest during these months (SEA 1993).

2. Adaptive or event driven sampling

Routine sampling along transects will be run on time scales of hours to weeks depending on the problem being pursued. For example, physical measurements during daytime and nighttime transitions in feeding behavior will be conducted on time scales of hours, while changes in large scale advection will be determined on scales of days to weeks. There will also be an opportunistic, event driven component to the sampling regime that will maximize the flexibility and therefore optimize the conditions under which certain types of sampling occur. Examples of event driven sampling are determining the advective regime and associated plankton and fish assemblages before, during, and after the passage of: (1) the juvenile pink salmon outmigration, (2) major low pressure systems through the PWS/North Gulf of Alaska region, or (3) when unexpected large aggregations of macrozooplankton or schools of fish are observed in an area.

3. Future timing

SEA is a long-term ecosystem project to be implemented in three phases: (1) an initial 1-2 year phase of preliminary modeling, planning, and field surveys that involve model

development, technological research and field reconnaissance; (2) an intensive 4-5 year phase of field research that is supplemented with microcosm and laboratory studies focussed on production and trophic interactions, and model testing and improvement; and (3) an extended phase of routine monitoring and model validation, and perhaps involving adaptive management manipulations of stocking and harvest practices. Initial studies should commence in 1994-95 with this proposal.

A generalized annual schedule is: (1) January to March - staging for the field season, (2) March to April 1994 - surveys of Pacific Herring spawning, (3) April to July 1994 - surveys of juvenile pink salmon outmigration, (4) August to September - juvenile Pacific herring and forage fish nearshore surveys, (5) September to February - data analysis, (6) October to March - Pacific herring overwintering surveys, (7) November - macrozooplankton overwintering survey, (9) December - annual reporting, (10) January - SEA Workshops for outside review and presentations, Cordova.

4. Terms of performance.

This is to be a cost reimbursable contract with one annual report. Monthly invoices for expenses will be submitted. . Figure 2 presents the 1994-95 and 1996+ tentative time schedules.

Table 2: Schedule for Physical Oceanographic Vessel in 1994.

Date	Activity
April 17-20	Hinchinbrook/Montague Strait
April 26-27	Hinchinbrook/Gulf of Alaska (GOA)/Central PWS
May 9-12	Hinchinbrook/Montague Strait
May 22-25	Hinchinbrook/Montague Strait
June 1-4	Hinchinbrook/Montague Strait
June 12-15	Hinchinbrook/GOA/Central PWS
June 23-26	Hinchinbrook/Montague Strait
July 8-11	Hinchinbrook/GOA/Central PWS
July 19-22	Hinchinbrook/GOA/Central PWS
July 29-Aug. 1	Hinchinbrook/GOA/Central PWS

Table 3: Schedule for Predation Rate and Predator Distribution Surveys

Time Period	Activity
Predation Rate Surveys	
April 16 - April 26	Northwest PWS Survey
May 1 - May 10	Northwest PWS Survey
May 15 - May 25	Northwest PWS Survey
June 1 - June 10	Northwest PWS Survey
June 16 - June 27	Southwest PWS Survey
July 11 - July 22	Southwest PWS Survey
Predator Distribution Surveys	
April 1 - April 7	Western PWS Survey
April 12 - April 15	Northwest PWS Survey
May 11 - May 14	Western PWS Survey
June 11 - June 15	Western PWS Survey
July 6 - July 10	Western PWS Survey
August - March	Nearshore Surveys

Figure 2: **Time Schedule for SEA FISH, 1994 and 1995 and beyond**

Year 1 - 1994

month (across)	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. hire staff	s	-------	c					
2. purchase equipment	s	-------	c					
3. assemble and field test equipment		s	----------	----------	c			
5. reconnaissance		s	---	c				
6. monitoring			s	----------	----------	----------	----------	*
7. data reduction				s	----------	----------	----------	*
8. data analysis					s	----------	----------	*
9. reporting and invoices	#1			#2				#3

* dependent upon continuation of SEA

1995 and beyond

month (across)	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. monitoring	s	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	c
2. reporting			#4			#5			#6			#7
3. workshops				*								

E. EXISTING AGENCY PROGRAMS

1. Related Studies in the EVOS 1994 Draft Work Plan.

Besides the projects incorporated in SEA, others will benefit from interaction with ongoing EVOS Trustee sponsored projects, most notably those listed here. We expect that many of these projects could be profitably informed by the results of the SEA program as well. Some support is requested in this proposal to conduct research complementary to several of these studies in collaboration with the investigators on those projects (work proposed here is complementary to, rather than overlapping with, work proposed in the projects listed below).

94064	Harbor seal habitat use and monitoring
94070	Restoration of high intertidal fucus
94083	Monitoring of oiled and treated shorelines
94086	Herring Bay experimental and monitoring studies
94102	Marbled murrelet prey and foraging habitat in PWS
94147	Comprehensive monitoring program
94159	Marine bird and sea otter boat surveys
94163	Forage fish influence on injured species.
94165	Herring genetic stock identification, PWS
94166	Herring spawn deposition, reproduction
94184	Coded wire tag recoveries of pink salmon
94185	Coded wire tagging of wild pink salmon
94187	Otolith marking of pink salmon
94189	Pink salmon stock genetics
94191	Pink salmon egg mortality
94192	Evaluation of hatchery straying
94244	Harbor seal and sea otter co-op subsistence harvest assistance

F. ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS

SEAFISH will not cause a significant environmental impact and, therefore, should qualify for a categorical exclusion from the requirements of the National Environmental Policy Act.

G. PERFORMANCE MONITORING

An internal quality assurance and control program will be instituted through the modeling and data management project. Independent review of performance will be conducted continuously by the Prince William Sound Fisheries Ecosystem Research Planning Group (PWSFERPG) board and at specific times via annual reports and workshops. Such review, begun in the December 1993 workshop, will work with the planning project to guide further development of the ecosystem research program, and ensure that the studies are integrated.

H. COORDINATION OF INTEGRATED RESEARCH EFFORT

The SEA-FISH project will be closely coordinated with SEA-OCEAN (Oceanography) and SEA-DATA (Information and modeling) for large scale data acquisition and analysis. SEA-FISH will be integrated with pink salmon growth and survival and encompass overwintering herring survival studies. Other apex predator studies, marbled murrellets, pigeon gullimots, and harbor seals will be cooperatively sampling in the field. Where possible, SEA-FISH will supply support for counting marine mammals and birds on plane and air transects where fish assessments are being conducted.

I. PUBLIC PROCESS

The SEA plan was developed by the people in PWS for PWS. The initial formation of a planning group was between the Alaska Department of Fish and Game, Cordova District Fishermen United, PWS Aquaculture Corporation, PWS Science Center, the PWS Oil Spill Recovery Institute and concerned fishermen. When news of the long-term ecosystem planning effort spread, the group expanded by the addition of representatives from the City of Cordova, the Eyak Corporation, the PWS Conservation Alliance, Cordova Aquatic Marketing Association, the University of Alaska Fairbanks and numerous concerned citizens. This effort later was joined by the PWS Communities Organized to Restore the Sound (PWSCORS) which includes Chenega Bay, Tatitlek, Valdez, Whittier, and Cordova. The expanded group was named the PWS Fisheries Ecosystem Research Planning Group (PWSFERPG).

The SEA plan incorporates what the people in PWS feel is important to know to protect their future quality of life in the Sound. The magnitude of the oil spill settlement and lack of tangible evidence of progress toward understanding the ecosystem has brought the regional public together to work as planners for their ecosystem. This process has been awkward for the traditional decision making structure to accommodate, but the rewards in bringing the people of the region into the decision making process are long term and offer the best way to implement ecosystem conservation practices.

J. PERSONNEL QUALIFICATIONS

G.L. Thomas, Ph.D., President and Director, Prince William Sound Science Center; Director, Prince William Sound Oil Spill Recovery Institute, P.O. Box 705, Cordova, AK 99574, (907) 424-5800, FAX 424-5820, Home 424-3117. **Education:** Ph.D. (Fish/1978/Univ. of Washington), MS (Zoo/1973/San Diego), B.A. (Bio-Chem/1970/CalWest). **Professional Experience:** 1990-present: PWS Science Center; 1973-89: student/research staff/faculty, University of Washington; 1971-73: research staff, Scripps Institute of Oceanography. **Publications:** 33 journal and peer reviewed papers, 11 proceedings papers, 56 technical reports and editor of two dedicated journal issues. **Selected publications:** Thomas, G.L. and Ole Mathisen, 1993, *Biological interactions between enhanced and wild salmon in Alaska.* 18(1-2):1-19. Fisheries Research. Thomas, G.L. 1992. *Successes and Failures of Fisheries Acoustics - An International, National and Regional Perspective.* 14:95-105. Fisheries Research. Thomas, G.L., Backus, E.H., Christensen, H.H.. and Weigand, J. 1991.

Prince William Sound/Copper River/North Gulf of Alaska Ecosystem. James Dobbin Associates, Alexandria, Virginia, 15 pp. Thomas, G.L. and Jackson, Darrell R., 1987. *Acoustic measurement of fish schools using array phase information.* Canadian Journal of Fisheries Aquaculture Science 44(9):1544-1550. **Research Projects:** >50 projects as principal investigator, >$5 million. **Teaching:** >20 graduate students, 4 Ph.D.'s. **Societies:** American Fisheries Society (life), AAAS, AFIRB, PFB. **Professional Panels:** NURC, NAML-WAML. **Affiliation:** Faculty, University of Alaska Fairbanks (IMS).

Vincent Patrick, Ph.D., Research Associate, Institute for Systems Research and the Advanced Visualization Laboratory, University of Maryland, College Park, Maryland 20742. **Education:** Ph.D., 1987, Mathematics, University of Maryland; M.S., 1982, Mathematics, University of Maryland; B.A., 1967, Physics, Thiel College. **Professional Experience:** 1993-present, Res. Assoc., Institute for Systems Research, UMD; 1992-93, Res. Sci., Chesapeake Biological Lab, UMD; Computer systems administration, visualization, mathematical modelling, Chesapeake Bay blue crab winter survey (with B.J. Rothschild, J.S. Ault). 1991-92, Res. Assoc., Astronomy, UMD; Start up of the Advanced Visualization Lab. 1988-91, Res. Sci., Chesapeake Biological Lab, UMD; Underwater acoustics (Lake Michigan, Chesapeake Bay), development of visualization resources for marine applications, mathematical modelling (with S.B. Brandt, D.M. Mason). 1968-82, Night Vision & Electro-Optics Lab, U.S. Army; image intensifier development. **Selected Publications:** D.M. Mason, E.V. Patrick, A model for the space-time dependence of feeding for pelagic fish populations, *Trans. Am. Fisheries Soc.*, 1993 in press. B.J. Rothschild and E.V. Patrick, Generation of a phytoplankton maximum in a grazing-extended logistic model, *Fisheries Oceanography*, 1993 in press. S.B. Brandt, D.M. Mason, E.V. Patrick, Spatially explicit models of fish growth rate, *Fisheries*, 17(2):23-35, 1992.

Robert D. DeCino, Aquatic Ecologist, Prince William Sound Science Center, P.O. Box 705, Cordova, Alaska 99574. **Education:** Masters of Science 1992, Utah State University, Aquatic Ecology, Logan Utah; Bachelor of Science 1986, Colorado State University, Fort Collins Colorado. **Professional Experience:** 1993 - present PWS Science Center; 1990-1992 student Utah State University; 1986-1989 Computer Systems Engineer, IBM Corporation, Anchorage, Alaska; 1982-1986 student Colorado State University.

Jay Kirsch, Electrical Engineer, Prince William Sound Science Center, P.O. Box 705, Cordova, Alaska 99574. **Education:** Bachelors of Science in Electrical Engineering, 1991, SUNY, T.J. Watson School of Engineering, Binghampton. **Professional Experience:** 1994-present PWS Science Center, 91-94 Chesapeake Biological Laboratory, created software to process bioacoustical, geographical and physical data, 90-91, General Electric, Software systems engineer, 87-91, Music Dept., SUNY, Sound engineer. **Selected Publications:** Brandt, S.B., and Kirsch, J., Spatially-explicit models of striped bass growth in the mid-Chesapeake Bay, *Transactions of the American Fisheries Society,* In press 1994.

K. BUDGET

Budget for SEA Nearshore Fish Program

Table 5: Budget summary for the salmon predation component of the SEA program in FY94, FY95 and FY96 and beyond, less equipment. Budgets for FY95 are subject to revision as the SEA and SEA-FISH program develops.

Line Item	FY94	FY95	FY96 and beyond
Personnel	180.669	189.732	207.600
Travel	51.467	56.744	14.900
Contractual	11.690	13.000	45.800
Supplies	14.660	14.668	21.700
Equipment	270.877	313.000	tba*
Direct costs	529.363	587.144	290.000
Indirect costs	62.037	65.795	68.800
Total Costs	**591.400**	**652.939**	**358.800***

*equipment costs are to be determined

EXXON VALDEZ TRUSTEE COUNCIL
1994 Federal Fiscal Year Project Budget
October 1, 1993 - September 30, 1994

Project Description:

Sound Ecosystem Assessment, Nearshore Fish (SEA-FISH) will use underwater acoustics and optics, and aerial optics to map distributions and assess biomass of the fish and plankton assemblage in Prince William Sound. SEA-FISH will provide large and fine scale trophic structure information to the SEA model where it will be integrated with ocean state and pink salmon or Pacific herring information.

Budget Category:	1994 Project No. Authorized FFY 94	'94 Report/ '95 Interim* FFY 94	Remaining Cost** FFY 95	Total FFY 95	FFY 96
Personnel	$ 180,669	$47,433	$ 142,299	$ 189,732	
Travel	51,467	14,186	42,558	56,744	
Contractual	11,690	3,000	10,000	13,000	
Commodities	14,660	3,917	10,751	14,668	
Equipment	270,877 *	0	313,000	313,000	
Capital Outlay	0	0	0	0	
Subtotal	529,363	68,536	518,608	587,144	
General Administration	62,037	16,449	49,346	65,795	
Project Total	$ 591,400 1*	$ 84,985	$ 567,954	$ 652,939	
Full-time Equivalents (FTE)					

Dollar amounts are shown in ~~thousands~~ of dollars.

Budget Year Proposed Personnel: Position Description	Reprt/Intrm Months	Reprt/Intrm Cost	Remaining Months	Remaining Cost
G.L. Thomas, Principal Investigator, Six (6) months @ $6,542/mo	$51,028			
Robert DeCino, Project Leader, Seven (7) months @ $3,520/mo	$32,032			
Electrical Engineer, Seven (7) months @ $3,333/mo	$30,330			
Ecologist/Modeler, Five (5) months @ $3,520/mo.	$22,880			
Senior Acoustician, 500 hours @$27/hour	$15,525			
Ecologist, 500 hours @ $20/hour	$11,500			
Technician, Hours (1259 @ $12/hour)	$17,374			
Personnel Total	$180,669			

*** $65,010 of indirect costs are waived on equipment based upon ownership residing with PWSSC**

**** SEAFISH 1994 Project Budget totals $591,400**

NEPA Cost:
*Oct 1, 1994 - Jan 31, 1995
**Feb 1, 1995 - Sep 30, 1995

07/14/93

1994

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Project Number: 94320
Project Title: Sound Ecosystem Assessment
Sub-Project: Nearshore Fish (SEA-FISH)
Agency: Prince William Sound Science Center, %University of Alaska Fairbanks

FORM 3A SUB-PROJECT DETAIL

EXXON VALDEZ [illegible]STEE COUNCIL
1994 Federal Fisc[illegible]r Project Budget
October 1, 1993 - September 30, 1994

				Reprt/Intrm	Remaining
Travel:	InState Travel:				
	Airfare	3 R/T Cor/Jnu @ $352 ea.	$1,056		
		6 R/T Cor/Anch @ $224. ea.	$1,344		
		2 R/T Cor/Fbks @ $456. ea	$912		
	Per Diem	19 Juneau days @ $128/day	$2,432		
		42 Anchorage days @ $170/day	$7,140		
		11 Fairbanks days @ $140/day	$1,540		
	Car Rental	50 days @ $30/day	$1,500		
	Misc. Expenses		$758		
	PWS Air Charters, 85 hours @ $230/hr		$19,550		
	Out-of-State Travel				
	Airfare	1 R/T Cor/SF @ $1,132/ea.	$1,132		
		3 R/T Cor/Sea @ $778/ea.	$2,334		
		3 R/T Sea/Halifax @ $1,683/ea.	$5,049		
	Per Diem	10 San Francisco days @ $134/day	$1,340		
		27 Halifax days @ $153/day	$4,131		
	Car Rental	28 days @ $30/day	$840		
	Misc. Expenses		$409		
		Total Travel	$51,467		
			Travel Total	$ 51,467	
Contractual:					
	CONTRACTUAL SERVICES				
	Telephone		$1,230		
	Facsimile		$1,260		
	Copying		$2,450		
	Mail, freight and shipping		$2,550		
	Office Equipment maintenance and repair		$1,250		
	Electronic mail and communications costs		$2,950		
		Total	$11,690		
			Contractual Total	$ 11,690	

07/14/93

1995

Printed: 3/23/94 6:02 PM

Project Number: 94320
Project Title: Sound Ecosystem Assessment
Sub-Project: Nearshore Fish (SEA-FISH)
Agency: Prince William Sound Science Center
%University of Alaska Fairbanks

FORM 3B
SUB-
PROJECT
DETAIL

EXXON VALDEZ TRUSTEE COUNCIL
1994 Federal Fiscal Year Project Budget
October 1, 1993 - September 30, 1994

Commodities:

		Reprt/Intrm	Remaining
COMMODITIES			
Analytical software	$975		
Statistical software	$1,221		
communications software	$850		
UPS (power supplies) 4 @ $250/ea.	$1,000		
4 Mustang Suits @ $250/ea	$1,000		
4 Survival suits @ $750/ea	$3,000		
Raingear, boots - 4 sets @ $150/ea	$600		
Electrical/Mechancial tools	$994		
Marine Hardware	$1,110		
Office Supplies	$895		
Video tapes, disks, film	$1,005		
Calibration and maintenance	$2,010		
	$14,660		
Commodities Total		$14,660	

Equipment:

BioSonics DT4000/4500/5000, 38, 120/420, 200/420, 720/1000 kHz portable, digital, dual and split beam, scientific sounder systems: 4 @ $25,916/ea.	$103,660	Tektronix disubulmation color printer	$13,999
Sonar system accessories		Seagate barracuda disk drive (2 gigabytes)	$2,212
Pentium color notebook computer w/2 PCMCIA slots, 4 @ $4,799	$19,196	Sun 1.7 gigabyte CDROM, 8mm, and .25" tape drive, w/ optical disk drive storage system	$4,765
HP560 Color Inkjet printer, 4 @ $902/ea.	$3,608	InFocus screen projection system	$4,795
Optical data storage systems, 4 @ $4,989/sys	$19,956	Nikon 35 mm camera w/wide angle and telescopic lens	$2,315
8' BioFin Towed Body, 2 @ $4,970/ea	$9,940	Sony, high 8mm, 3 chip video camera	$6,899
4' BioFin Towed Body, 2 @ $2,735/ea	$5,470	Frame Grabber	$3,412
Standard targets (38-1000 kHz) 6 @ $600/ea.	$3,600		$ 270,877
50' tow cables w/ 25' faring, 4 @ $3,300/ea.	$13,200		
Acoustic survey vessel, 27' - 32', dry hull, large cabin, twin outboards	37,476		
Polaroid color pallet	$6,499		
Sun Sparc 2 workstation	$9,875		
Equipment Total		$ 270,877	

07/14/93

1995

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Project Number: 94320
Project Title: Sound Ecosystem Assessment
Sub-Project: Nearshore Fish (SEA-FISH)
Agency: Prince William Sound Science Center
%Univ[illegible] of Alaska Fairbanks

FORM 3B
SUB-
PROJECT
DETAIL

SFOS 94320P
946

RESEARCH PROPOSAL

TO: Mr. James Ayers, Executive Director
EVOS Trustees Council, Restoration Office
645 G Street, Anchorage Alaska 99501
(907) 276-8012, -7176 facsimile

FROM: Institute of Marine Science (IMS)
School of Fisheries and Ocean Sciences (SFOS)
University of Alaska Fairbanks (UAF)
Fairbanks, Alaska 99775-1080

and

Prince William Sound Science Center (Science Center)
P.O. Box 705, Cordova, Alaska 99574
(907) 424-5800, -5820 facsimile

TITLE: Sound Ecosystem Assessment (SEA)
Planning and Communication (SEA-PLAN)

PRINCIPAL INVESTIGATORS:

Dr. Donald Schell
Director, Institute of Marine Science
School of Fisheries & Ocean Sciences, University of Alaska Fairbanks (IMS/SFOS/UAF)

Dr. David Scheel
Prince William Sound Science Center

NEW OR CONTINUING: New

PROPOSED STARTING DATE: March 1, 1994

PROPOSED DURATION: Two years

AMOUNT REQUESTED: FY94 SEA-PLAN - Total $ 49,600.
FY95 SEA-PLAN - Total $ 110,375.

Don Schell /R[3] 4/13/94
Don Schell Date
Director, IMS/SFOS-UAF
(907) 474-7531

David Scheel Date
Principal Investigator
(907) 424-5800

A.V. Tyler 4/18/94 Date
Associate Dean, SFOS
(907) 474-6732

Ted DeLaca 4/21/94 Date
Director, Office of Arctic Research

Joan Osterkamp 4-12-94 Date
Executive Officer, SFOS
(907) 474-7824

G.L. Thomas Date
President, PWS Science Center
(907) 424-5800

EXXON VALDEZ **TRUSTEE COUNCIL**
FY 94 DETAILED PROJECT DESCRIPTION

A. COVER PAGE

Project title: Sound Ecosystem Assessment (SEA), An Ecosystem Research Plan for Prince William Sound -- Planning and Communication (SEA PLAN)

Project ID number: 94320P

Project type: Research/Monitoring

Name of project leader(s): Dr. David Scheel, Ecology, Prince William Sound Science Center

Lead agency: Prince William Sound Science Center

Cooperating agencies: University of Alaska Fairbanks (UAF), Alaska Department of Fish & Game (ADF&G), Department of Interior/U.S. Fish & Wildlife Service (DOI/USFWS)

Cost of project/FY 94: $49.6 K
Cost of project/FY 95: $110.4 K
Cost of Project/FY 96 and beyond: $110.4 K + inflation

Project Start-up/Completion Dates: FY94: March 1, 1994-September 30, 1994
FY95: October 1, 1994-September 30, 1995

Geographic area of project: Prince William Sound and North Gulf of Alaska

Name of project leader: Dr. David Scheel

Name of lead agency project manager: Dr. Jerome Montague, Alaska Dept. of Fish & Game

B. INTRODUCTION

The chief goal of SEA is to improve our understanding of ecosystem level processes in Prince William Sound (PWS), with particular regard to how natural and anthropogenic perturbations influence ecosystem processes. Recent run failures of wild and hatchery pink salmon, as well Pacific herring stocks, have focused our attention on the roles of these fish in the marine ecosystem. However, our present understanding of the marine ecosystem does not allow us to discern whether these run failures were due to natural or anthropogenic processes, underscoring the need to gain a more comprehensive understanding of the PWS ecosystem. In this context, the Sound Ecosystem Assessment (SEA) research plan is initially focused on components of the PWS ecosystem called the "fisheries ecosystem;" this includes those elements of the PWS ecosystem important in limiting the production of fish stocks. The first phase of SEA will focus on pink salmon and Pacific herring stocks as target species, because of their major ecological roles in the Sound, as well as their economic importance to the communities of the Sound. The fisheries ecosystem is defined to include the predators, competitors and prey associated with specified target species throughout their life history, as well as environmental processes that act to constrain the production of the target fish species.

It is recognized that this trophic structure supports many non-commercial fish as well as bird and mammal populations of interest to the EVOS Trustee Council. The ecosystem perspective used in SEA will identify and analyze processes within the Sound that act to limit the production of the target fish species. The SEA program studies on the interactions between key organisms and their physical and biological environments are the first steps to improving our understanding of the PWS ecosystem. This ecosystem approach is highly applicable to other target species including other fish, seabirds and marine mammals.

The central scientific goals of SEA are: (1) to increase understanding of processes that determine the abundance of key animal populations in the Sound, initially pink salmon and Pacific herring have been chosen, (2) to develop and apply new methods and technologies for evaluating life history parameters of key populations (initially marine species) important to evaluating the key animal populations, and (3) to acquire the ability to predict how the abundances of key animal populations change.

Scientific reviews of SEA at the December 1993 Ecosystem Workshop in Cordova were favorable: the reviewers called the plan innovative, reasonable, and scientifically testable. The reviewers also identified areas where additional attention was merited to augement SEA or strengthen an ecosystem approach to EVOS research. In particular, reviewers suggested that further attention to apex predator populations (sea birds and marine mammals), the intertidal and benthic systems, and to toxicology was warranted.

As SEA provides an increased understanding of how physical and biological factors interact within the ecosystem to limit the production of fish stocks, the next step is to

ask how variation in fish production interacts with other variables in the system to alter population dynamics at higher trophic levels (e.g for animals such as sea birds and marine mammals). Beyond this, aspects of nutrient cycling between the continental shelf marine system and intertidal or benthic systems make a natural next step.

SEA researchers have already developed cooperative sampling designs with Alaska Department of Fish and Game on sockeye salmon and harbor seals, the U.S. Fish and Wildlife Service on marble murrelets, pigeon guillemots, and kittiwakes, and the Copper River Delta Institute/U.S. Forest Service on gulls, sea ducks and shorebirds. Cooperative sampling with researchers on killer and humpback whales is pending and we are seeking an agreement with NOAA on forage groundfish assessments. Ultimately, we see listing the marine and terrestrial subsystems in the PWS comprehensive ecosystem model. However, further planning within the SEA program is needed to continue to develop and evaluate preliminary models of important ecosystem processes. These models will be of the same type that led to the development of key testable hypotheses in the SEA program as designed for 1994. They are expected to lead to the development of additional testable hypotheses by expanding on existing SEA models and incorporating results from initial SEA field research.

Achieving the goals SEA has laid out will ultimately address scientific and public concerns about the health of this valuable Alaskan coastal environment. Benefits will be first evidenced by having scientists and fishermen work together in the field, which will build public trust in scientific methods. Second, ongoing, local, public education and outreach programs will be enhanced by having a comprehensive, locally available, scientific data base on the status of PWS resources. In addition, the availability of new information and the technologies to acquire better information will allow improved harvest management strategies to be developed. Ultimately, better forecasts of animal abundance and improved predictions of population responses to natural and anthropogenic perturbations will allow a policy of sustainability to be established. Sustainability is the insurance that local communities of the Sound need to protect their standard of living. This involvement of community interests and expertise does not happen without careful preparation, however. Some coordination of communication is needed between PWSFERPG constituent organizations, the public, SEA scientists, agencies, and the Trustee process.

C. PROJECT DESCRIPTION

1. Resources and/or Associated Services:

The Sound Ecosystem Assessment (SEA) program evaluates changes occurring in the Prince William Sound (PWS) ecosystem in the context of groups of interacting species. Implementation of the SEA program will result in vital knowledge for determining the feasibility of, and the approach to, restoration of many resources and services injured by the Exxon Valdez Oil Spill (EVOS). Resources addressed by SEA

include pink salmon, herring, and the principal species interacting with these fishes. These pelagic organisms support a host of birds and mammals, some of which are listed as injured species of the EVOS. Services addressed include subsistence, commercial fishing, recreation and tourism, and passive use. While SEA is primarily a monitoring and research activity, this program will also support other EVOS Trustee Council programs (i.e., providing better information to land and fisheries management personnel that will promote a healthy ecosystem, and increasing public awareness of the state of the ecosystem).

As an integrated part of the SEA program, all resources and services benefiting from SEA stand to gain from careful planning, communication and community involvement. Future expansion of the SEA program will involve development and evaluation of hypotheses regarding the role of apex predators (sea birds and marine mammals) in ecosystem processes, coupling pelagic and nearshore benthic ecology, and linking aquatic and terrestrial ecology through dominant ecosystem pathways. Hypotheses must be evaluated not only for their scientific merit, but with consideration of their role in furthering an integrated, Trustee-sponsored ecosystem research program.

2. Relation to Other Damage Assessment/Restoration Work:

Initial collaborations in 1994 and further planning for work to be implemented beginning in 1995 will focus on expanding SEA to address the roles of sea birds, marine mammals, and ecotoxicological factors in the marine system. Work has already begun to build connections with ongoing projects in these areas (see above). The sampling design, technology and modeling efforts used in this study of Prince William Sound should also be transferable to other parts of the spill area, especially for sea birds and mammals.

3. Objectives:

(1) Continued Scientific Planning: Develop conceptual models of key ecosystem processes to link SEA research and results to an improved understanding of the greater ecosystem, including (a) apex predators, (b) benthic and intertidal communities, and (c) toxicological pathways and effects. This work will provide a framework to aid SEA integration with other EVOS research on sea birds, mammals, and other fishes, as well as direction for further SEA projects. Since the selection of dominant species as key populations (Pacific herring and pink salmon) in Prince William Sound is a way to best represent the pelagic-nearshore ecosystem, it allows for successful integration with many of the ongoing apex predator studies in the region, regardless of oil-spill relationship. Nearly all pelagic-nearshore, apex predator populations are subject to the same ocean state conditions and dependent upon the dominant species, and/or the prey and predator populations that are monitored on the large scale. Thus, whether bird or mammal, the integration of apex predator studies with SEA is an efficient and meaningful approach to improving ecological studies in the region.

There are no sharp boundaries between the pelagic-nearshore, intertidal ecosystems and the marine and terrestrial ecosystems. They are linked by the transfer of carbon and nutrients via the migrations of animal populations that feed on marine production. There are exciting areas of future cooperation and an expanded ecosystem studies program can lead to a link of the SEA program with terrestrial resource ecosystem evaluations.

(2) Communication and community involvement: Solicit the continued input of regional communities in the design and implementation of SEA, through maintaining open communications with regional organizations (e.g. fishermans' unions, PWSCORS) and through the periodic preparation and distribution of reports describing the progress and status of SEA programs. Although each SEA project will be responsible for reporting its own progress, SEA PLAN will be responsible for the compilation and distribution of such information to the community.

4. Methods:

Two methods will be used: First, conceptual and numerical modeling, combined with strategic plan development will be used to develop, refine and evaluate scientifically testable hypotheses. Carbon-budget, food-web, and population models will be employed, as well as other appropriate frameworks. This work will be coordinated by the Scientific Planner, but will receive the review and input of the SEA Scientific Committee.

Second, meetings, memos, maps, and reports will be used as needed to distribute information both among SEA scientists and to the regional community. Travel to Anchorage, Juneau and Fairbanks will allow SEA, EVOS and University programs to remain appraised about each other's planned research, thereby minimizing overlap between different EVOS-sponsored projects as they are developed. While all projects will have responsibilities for reporting their progress, the Communication Coordinator will ensure that all involved parties are apprised of developments in all areas, and will coordinate communication between PWSFERPG constituent organizations, the public, SEA scientists, agencies, and the Trustees.

5. Location:

This project will be conducted for Prince William Sound, the North Gulf of Alaska, and may involve other areas of the EVOS-impacted region if appropriate. Planning will involve organizations located throughout Alaska.

6. Technical Support:

The Planning and Communication portion of SEA will require the use of modeling and GIS computer services, as well as the continued involvement of the SEA Project Leaders and scientists. Computer services, including GIS, will be provided through

the Prince William Sound Science Center. Involvement of Project Leaders will be accommodated by coordination with the SEA DATA program under Dr. Vince Patrick. Communication with local communities and expertise will be achieved as in the past, through interaction with regional organizations such as fisherman's unions and the PWS Communities Organized to Restore the Sound.

7. Contracts:

None

D. SCHEDULES

Since August of 1993 the SEA project has been under intense development and now has come to fruition as a working program of ecosystem research in PWS and the EVOS region. There has been a tremendous amount of public input into the formulation of this project. SEA PLAN provides for the continuation of project development and public input during the period 1 Mar-30 Sep 1994 of FFY94.

PWSFERPG meetings have always been open to the public. Meetings in the past have occurred twice monthly or more frequently. At a minimum, open meetings will be held monthly during the field season (1 Apr 94 to 1 Aug 94) and twice monthly there after. The Communications Coordinator will be available for public contact, by telephone or drop-in office visits at least 4 hours per week from 1 Apr 94 to 30 Sep 94. These opportunities for public involvement are the minimum that will be provided. Many individual project leaders have active involvement of local resources and expertise in their programs. PWSFERPG has an 'open-office' policy and welcomes public input at any time.

E. EXISTING AGENCY PROGRAM

Agency contributors to this project will include all agencies involved in SEA research. Further planning and/or communications will be needed for: cooperative research and sampling designs with Alaska Department of Fish and Game on pink salmon, sockeye salmon and harbor seals, with the U.S. Fish and Wildlife Service on marble murrelets, pigeon guillemots, and kittiwakes, and with the Copper River Delta Institute/U.S. Forest Service on pink salmon, gulls, sea ducks and shorebirds. Cooperative sampling with researchers on killer and humpback whales is pending and we are seeking an agreement with NOAA on forage groundfish assessments.

F. ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS

SEA PLAN will not cause a significant environmental impact and, therefore, should qualify for a categorical exclusion from the requirements of the National Environmental Policy Act.

G. PERFORMANCE MONITORING

An internal quality assurance and control program will be instituted through the modeling and data management project (SEA DATA). Independent review of performance will be conducted continuously by the Prince William Sound Fisheries Ecosystem Research Planning Group (PWSFERPG) board and at specific times via annual reports and workshops. Such review, begun in the December 1993 workshop, will work with the planning project to guide further development of the ecosystem research program, and ensure that the studies are integrated.

H. COORDINATION OF INTEGRATED RESEARCH EFFORT

The purpose of SEA PLAN is to establish clear communications between SEA projects and related FFY94 work plans; and to update plans to keep SEA an integrated part of the total EVOS-related research effort. Scientific planning for SEA PLAN will utilize initial SEA results collated by SEA DATA. Planning will involve the active participation of SEA lead scientists and open communication with the public and the Trustee-process to ensure that planned developments and project direction are well-integrated with other EVOS-related research.

I. PUBLIC PROCESS

Sound Ecosystem Assessment (SEA) is an ongoing project with a mission to develop and advocate the best model for ecosystem research in Prince William Sound and the EVOS affected region. The concept of the SEA program has been in the region for several years. Since August of 1993 the plan has been under intense development and come to fruition as a working document to guide ecosystem research in PWS and the EVOS region. The SEA Science Committee includes scientists and resource managers from the University of Alaska, Alaska Department of Fish and Game, PWS Science Center, U. S. Forest Service and PWS Aquaculture Corporation. There has been a tremendous amount of public input into the formulation of this project. Input has been received from Prince William Sound Communities Organized to Restore the Sound (PWSCORS), Cordova District Fisherman United, Cordova Aquatic Marketing Association and numerous Prince William Sound fisherman. A workshop sponsored by the EVOS Trustee Council and NOAA was held in Cordova Alaska during December of 1993 to peer review the SEA document and to further plans for coordinated and integrated ecosystem research in Prince William Sound and the greater EVOS affected region. The purpose of SEA PLAN is to continue to encourage substantial

involvement of the public, and to develop streamlined communication pathways between SEA programs and the public in the EVOS-impacted region.

J. PERSONNEL QUALIFICATIONS

Scientific Planner:
David Scheel, Associate Scientist, Prince William Sound Science Center. Education: Ph.D. (Ecology, 1992, University of Minnesota), MS (Ecology, 1986, Univ. of MN), BS (Biology, 1980, Renesselaer Polytechnic Institute). Professional experience: 1993-present, Associate scientist, PWSSC; 1992-93, Postdoctoral associate, University of Houston; 1986-1992, Research scientist, Serengeti Wildlife Research Institute, Serengeti, Tanzania; 1984-1992, student/post-doc/consultant, Univ. of Minnesota. Selected publications: Scheel, D. & Packer, C. 1991. Group hunting behavior of lions: a search for cooperation. *Anim. Behav.* 41(4):697-709. Scheel, D. 1993. Profitability, encounter rates and the prey choice of African lions. *Behav. Ecol.* 4(1):90-97. Cameron, G.N. & Scheel, D. *In press.* Assessing effects of global climate change on mammals using GIS: A case study of lagomorphs and insectivores in Texas. *Geocarto International.* Research projects: Serengeti predator behavior and community dynamics, social behavior and resource use of primates in Gombe, impacts of global warming on mammal distributions and habitat use in Texas, frequency- and density-dependence in models of community evolution.

Communication Coordinator:
To be identified.

K. BUDGET

Budget for SEA Planning and Communication

Table 1: Budgets for FY95 are subject to revision as the SEA program develops.

Line Item	FY94	FY95	FY96 and beyond
Personnel	16,474	40,000	40,000
Travel	10,339	20,000	20,000
Contractual	2,400	0	0
Supplies	1,775	20,000	20,000
Equipment	0	0	0
General Administration	7,437	19,200	19,200
Direct costs	38,425	99,200	99,200
Indirect costs	11,175	11,175	11,175
Total Costs	**49,600**	**110,375**	**110,375**

EXXON VALDEZ [illegible]TEE COUNCIL
1994 Federal Fisca[illegible]r Project Budget
October 1, 1993 - September 30, 1994

Project Description:

This project is to provide continued integration of the SEAPLAN with new p[illegible]jects (birds, mammals and fish), educational outreach between SEA projects and the com[illegible]nities in the spill affected area, and coordination between existing SEA projects.

Budget Category:	1994 Project No. Authorized FFY 94	'94 Report/ '95 Interim* FFY 94	Remaining Cost** FFY 95	Total FFY 95	FFY 96
Personnel	$16,474	$ 10,000	$ 30,000	$ 40,000	
Travel	10,339	5,000	15,000	20,000	
Contractual	2,400	0	0	0	
Commodities	1,775	5,000	15,000	20,000	
Equipment	0	0	0	0	
Capital Outlay					
Subtotal	30,988	20,000	60,000	80,000	
General Administration	7,437	4,800	14,400	19,200	
Project Total	38,425*	$ 24,800	$ 74,400	$ 99,200	
Full-time Equivalents (FTE)					

Dollar amounts are shown in ~~thousands~~ of dollars.

Comment

*SEAPLAN PROJECT BUDGET

PWS Science Center	$38,425
University	$11,175**
SEAPLAN DPD budget	$49,600

** 44.7% of the first $25,000 of the PWS Science Center subcontract (projects SEAOCEAN, SEAFISH, SEADATA, SEAPLAN) that is charged by the University is shown here under contractual.

Budget Year Proposed Personnel: Position Description	Reprt/Intrm Months	Reprt/Intrm Cost	Remaining Months	Remaining Cost
Planner, 400 hours @ $20/hour+benefits $9,152				
Administrative Coordinator, 400 hours @ $16/hour +benefits $7,322				
Total $16,474				
Personnel Total				

NEPA Cost:
*Oct 1, 1994 - Jan 31, 1995
**Feb 1, 1995 - Sep 30, 1995

Project Number: 94320
Project Title: Sound Ecosystem Assessment Information and Management (SEA-Plan)
Sub-Project: Prince William Sound Science Center,
Agency: %University of Alaska Fairbanks

FORM 3A SUB-PROJECT DETAIL

EXXON VALDEZ TRUSTEE COUNCIL
1994 Federal Fiscal Year Project Budget
October 1, 1993 - September 30, 1994

Travel:		Reprt/Intrm	Remaining
TRAVEL			
Airfare			
2 round trips Cor/Jun @ $350 each	$ 700		
3 round trips Cor/Anch @ $224 each	$ 672		
2 round t rips Cor/PWS @ $456 each	$ 912		
Per diem			
12 Juneau days @ $128 each	$1,536		
28 Anchorage days @ $170/day	$4,760		
7 PWS days @ $140/day	$ 980		
Car rental			
25 days @ $30/day	$ 750		
Misc.	29		
Total Travel	$10,339		
	Travel Total	$ 10,339	

Contractual:			
CONTRACTURAL			
Telephone	$500		
Facsimile	$500		
Copying	$550		
Mail	$450		
Maintenance	$400		
Total ~~Commodities~~ Contractual	$2,400		
	Contractual Total	$ 2,400	

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1994

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Project Number:	94320
Project Title:	Sound Ecosystem Assessment
Sub-Project:	Information and Management (SEA-Plan)
Agency:	Prince William Sound Science Center, %University of Alaska Fairbanks

FORM 3B
SUB-
PROJECT
DETAIL

Commodities:	Reprt/Intrm	Remaining
COMMODITIES Paper, pens, tape, etc. $1,775		
Commodities Total		
Equipment:		
Equipment Total		

Project Number: 94320
Project Title: Sound Ecosystem Assessment
Sub-Project: Information and Management (SEA-Plan)
Agency: Prince William Sound Science Center, %University of Alaska Fairbanks

FORM 3B
SUB-
PROJECT
DETAIL

DETAILED BUDGET - PWS SCIENCE CENTER - SEAPLAN
(Information and Management)

March 1 to September 30, 1994

SALARIES	
Planner, 352 hours @ $20/hour	$ 7,040
Administrative Coordinator, 352 hours @ $16/hour	$5,632
Total Salaries	$12,672
BENEFITS	
30% of $12,672	$3,802
TRAVEL	
Airfare	
2 round trips Cor/Jun @ $350 each	$ 700
3 round trips Cor/Anch @ $224 each	$ 672
2 round trips Cor/PWS @ $456 each	$ 912
Per diem	
12 Juneau days @ $128 each	$1,536
28 Anchorage days @ $170/day	$4,760
7 PWS days @ $140/day	$ 980
Car rental	
25 days @ $30/day	$ 750
Misc.	29
Total Travel	$10,339
COMMODITIES	
Paper, pens, tape, etc.	$1,775
CONTRACTURAL	
Telephone	$500
Facsimile	$500
Copying	$550
Mail	$450
Maintenance	$400
Total ~~Commodities~~ Contractural	$2,400
TOTAL DIRECT COSTS	$30,988
INDIRECT COSTS 24% of TDC	$7,437
TOTAL PWSSC COSTS	$38,425
UAF ADMINISTRATIVE COSTS	
for PWSSC subcontracts	
(SEAOCEAN, SEAFISH, SEADATA and SEAPLAN)	
44.7% of first $25,000	$11,175
TOTAL COSTS	$49,600

94320Q

EXXON VALDEZ TRUSTEE COUNCIL
FY 94 DETAILED PROJECT DESCRIPTION

A. COVER PAGE

Project title: Sound Ecosystem Assessment (SEA), An Ecosystem Research Plan for Prince William Sound

Subproject title: Avian Predation on Herring Spawn

Project ID number: 94320

Project type: Research/Monitoring

Name of project leader(s): Dr. Mary Anne Bishop, Research Wildlife Biologist, Copper River Delta Institute, Pacific Northwest Research Station, US Forest Service

Lead agency: USDA, U.S. Forest Service, Pacific Northwest Research Station

Cooperating agencies: Alaska Dept. of Fish and Game, Prince William Sound Science Center, Univ. Alaska, US Fish & Wildlife Service

Cost of project/FY 94 (7 months): $85.0K

Cost of project/FY 95: $173.0K

Cost of Project/FY 96 to FY99: $427.1K

Project Start-up/Completion Dates: March 1, 1994/December 31, 1998

Geographic area : Herring Spawning Grounds Throughout Prince William Sound

Project Leader: Mary Anne Bishop — Mary Anne Bishop — 2/23/94 — Date

Project Manager: /s/ — Fred Everest — 2/23/94 — Date

B. INTRODUCTION

Pacific herring (Clupea pallasi) has been identified as a resource injured by the Exxon Valdez oil spill. Studies conducted from 1989-1992 have documented a significant decline of spawner biomass. In 1993, the total observed spawning population was less than one third of pre-season prediction (J. Wilcock, ADF&G, pers. comm.).

The SEA Plan hypothesizes that the recruitment success of herring populations in Prince William Sound (PWS) is related to losses due to physical processes (high energy coastal storms and temperature extremes) and to predation during early life stages (embryo to larval) that occur within the Sound. Understanding egg loss will allow for a better estimate of survival to the larval stage.

It is also important to understand egg loss from a fisheries management standpoint. Currently ADF&G estimates the adult spawner biomass from total egg deposition, average fish size and sex ratio, and average fecundity at size measured. Egg deposition surveys take place 5-10 days after spawning. Losses to predation and physical processes between deposition and surveys are needed to accurately calculate spawning biomass. Until now, only potential sources of predation have been identified in PWS.

Pacific herring return to PWS every April and deposit their eggs on rocks and vegetative substrate in the intertidal and shallow subtidal zones. Depending on seawater temperature, egg density and egg distribution, herring eggs hatch into drifting larva at approximately 20-25 days. Throughout incubation, egg loss or the removal of eggs from their original incubation environment (Palsson 1984) can be significant. During a 2-year study in 1990 and 1991 in PWS, rates of egg loss as high as 91.2% have been measured, with an overall estimated egg loss rate of 50.4% throughout the incubation period and a daily rate of 2.1% (Biggs and Baker, in prep.). During 1994, ADF&G will study egg loss again to facilitate construction of an egg loss model required by the SEA Plan and fisheries management stock assessment models.

Herring egg loss is regulated by two processes: predation and physical translocation through wave action and currents (Palsson 1984; Haegele and Schweigert 1991). Egg loss due to storm-induced wave action was investigated in two studies in British Columbia. Losses ranged from 28% (Hay and Miller 1982) to 40% (Hart and Tester 1934) with lower losses on adjacent spawning areas. This year ADF&G will begin to test meteorological condition as a factor in egg loss in PWS and work toward building a sound-wide embryo survival model.

Predators of herring spawn include invertebrates, marine mammals, fish, and birds. Epibenthic invertebrates (crabs, snails, and starfish) and birds have been identified as the greatest sources of egg loss on spawning areas in Washington and British Columbia. Predator exclusion experiments conducted by Palsson (1984) determined that large predators, primarily diving ducks and gulls, accounted for 20-50% of the daily egg loss rate on 3 of 6 plots. Smaller predators (snails and amphipods) were major contributors to egg losses in exclosures. Palsson, concluded, however, that since birds compete for herring eggs with these invertebrates, the contribution of bird predation to egg loss is greater.

Using exclosures, Outram (1958) estimated egg loss to avian predators on the west coast of Vancouver Island at 30-55% with an average of 39% of spawn deposition consumed by birds. Highest losses occurred the first 3 days of incubation when egg densities were highest, with some 66% of total spawn loss occurring then. Glaucous-winged gulls (Larus glaucescens) and herring gulls (Larus argentatus) were found to be responsible for most of the predation. Haegele and Schweigert (1991) estimated egg loss in southern British Columbia at 58%. Egg loss was greater in shallow water and at sites where diving ducks congregated. Overall, 7.1% of the eggs were lost to predation, including an estimated 3.0% to birds.

Prince William Sound has a large resident population of potential herring spawn avian predators including surf scoters (Melanitta perspicillata) and glaucous-winged gulls. Surf scoters are abundant in the region and the most numerous sea duck. Migrant surf scoters are numerous in April and May. Glaucous-winged gulls are also an abundant resident. Although they are present in numbers throughout the year, an influx does occur in spring, mainly between mid-april and mid-May (Isleib and Kessel 1973). The primary nesting colony for glaucous-winged gulls in PWS, estimated at approximately 10,000 pairs, is at Egg Island on the east end of Prince William Sound (Patten 1980). Egg laying usually begins around the second week in May.

Historically, large numbers of glaucous-winged gulls have been observed in areas with herring spawn. On 10 May 1989, approximately 30,000 gulls were observed in Rocky and Zaikof Bay on northern Montague Island. On 6 May 1992, an estimated 50,000 gulls were observed in areas with herring spawn on the northwestern shore of Montague Island (P. Martin, USFWS, pers. comm.).

Prince William Sound is also an important migratory stopover for shorebirds that prey on herring spawn. In 1989, northern Montague Island was discovered to be the most important spring staging area for two species of shorebirds: surfbirds (Aphriza virgata) and black turnstones (Arenaria melanocephala). Total numbers using the area are not known, however, in May 1992 a single day count of almost 56,000 surfbirds and 25,000 black turnstones was recorded (P. Martin, USFWS, pers. comm.). These numbers suggest that a high proportion of the world's population of these two species use northern Montague Island in spring (Norton et al. 1990; Martin in review).

Spatially and/or temporally then, herring spawn deposition in PWS coincides with breeding for a large resident population of glaucous-winged gulls, and with spring stopover areas for seaducks and shorebirds. To date, however, we have no information on numbers and distribution, and how predictable or variable the use of herring spawn is by resident and migrant birds. Nor has the importance of herring spawn in providing a high-energy food resource for egg laying and migration been determined. From a fisheries management standpoint information on avian predation is important because if the avian predator population remains relatively constant or increases, then the lower herring stock levels that PWS is currently experiencing could experience higher rates of predation.

What follows is a description of a multi-year project that will investigate avian predation on herring spawn. As part of the SEA plan, it is designed to complement ongoing long-term studies on herring spawn deposition and survival. The cost of this project is reasonable when one considers the economic aspects of the commercial fisheries alone and not including the important contribution that herring makes to the ecosystem in PWS during all life stages. The exvessel value of the herring fisheries in 1992 was $12.0 million with an average annual value of $8.3 million. This compares to an exvessel of $2.0 million in 1993.

C. PROJECT DESCRIPTION

This project will assess and document the impact of avian predation on herring spawn in Prince William Sound. Results will eventually be integrated into a model relating sound-wide embryo survival to predation, habitat type, egg density, and meteorological conditions.

1. Resources and/or Associated Services:

The resources to be studied by this project are the avian predators on Pacific herring spawn (seabirds, seaducks, and shorebirds). Herring is a major commercial and minor subsistence resource in PWS. Ecologically, herring are an important forage base for a large number of fish and mammal predator species, as well as birds.

2. Relation to Other Damage Assessment/Restoration Work:

This project will provide critical information for EVOS Project No. 94166, Herring spawn deposition and reproductive impairment. This project is being conducted by the Alaska Department of Fish and Game (spawn deposition) and NOAA (reproductive impairment). The goal of Project No. 94166 is to improve herring fisheries management in Prince William Sound by determining accurate and precise estimates of herring abundance. A better understanding of the loss of herring spawn to avian predators will improve estimates of egg loss used in current stock assessment models. These models are used by fishery managers to set herring harvest quotas. As part of the SEA Plan, this project will also provide further information on the regulating effect that bird predation has on recruitment into the herring population.

3. Objectives:

a. Examine the phenology, relative abundance, and species composition of birds foraging in herring spawn areas in the rocky intertidal and subtidal habitats.

b. Examine spatial and temporal distribution (including length of stay for shorebirds only) in relation to habitat type and abundance of pacific herring spawn.

c. Assess the relative importance of prey, in particular herring spawn, for birds using nearshore habitats. Calculate the extent of losses of herring eggs to these birds using a combined analysis of bird and herring spawn distributions.

4. Methods:

The impact of avian predation on herring spawn will be documented by observing the distribution and relative abundance of birds foraging in herring spawn areas and by analyzing their diets. Herring spawn deposition density and subsequent egg loss will be documented by a concurrent ADF&G study. The extent and distribution of herring spawn will be documented from daily aerial flights conducted as a regular part of ADF&G commercial fisheries management.

The first year of this study will focus on identification of avian predators and their relative abundance, and the importance of spawn in their diets. Beginning the second year, this project will be scaled up to include more complete coverage of spawn areas, and to determine the relative numbers, movements, and length of stay for surfbirds and black turnstones staging on northern Montague Island.

a. Study area

For the first year of this study, the study area consists of all locations in PWS with herring spawn that are sampled at ADF&G spawn deposition surveys. An intensive study will be conducted at northern Montague Island from Port Chalmers to Zaikof Bay (Figure 1). High densities of herring spawn have occurred in this area nine of the last ten years (E. Brown, ADF&G, pers. comm.). Northern Montague Island also hosts the highest numbers of migrant surfbirds and black turnstones from late April through May. More than 80,000 of these shorebirds were observed at one time in association with the herring spawn (P. Martin, USFWS, pers. comm.).

b. Data collection

The phenology, relative abundance and species composition of birds using herring spawn will be documented using boat and aerial shoreline surveys. Three types of boat transects will be conducted: 200m wide shoreline transects, intertidal zone surveys, and 100m x 300m shoreline transects.

Boat surveys. Beginning 8 April (approximately one week prior to estimated initial herring spawn deposition) and through 20 May, boat surveys will be conducted for seabirds, seaducks, and shorebirds from Stockdale Harbor to Montague Point (Figure 1). The starting point will be randomly switched each day between either end of the survey area. On days when weather prohibits travel outside of Stockdale Harbor, the survey will be restricted to the shoreline within the harbor.

Data collected for all boat surveys will include: number and species (or genus), shoreline type, and habitat (land, water or air). For seabirds and seaducks, the area within 200m of shore will be surveyed. The shoreline will be divided into transects based on natural landmarks and/or shoreline type. Transects will be surveyed using methodology adapted from the US Fish and Wildlife Service's marine birds and mammal surveys (USFWS 1991). Shorelines will be surveyed on alternate days (weather permitting) at a distance of 100m from shore and at a cruising speed of

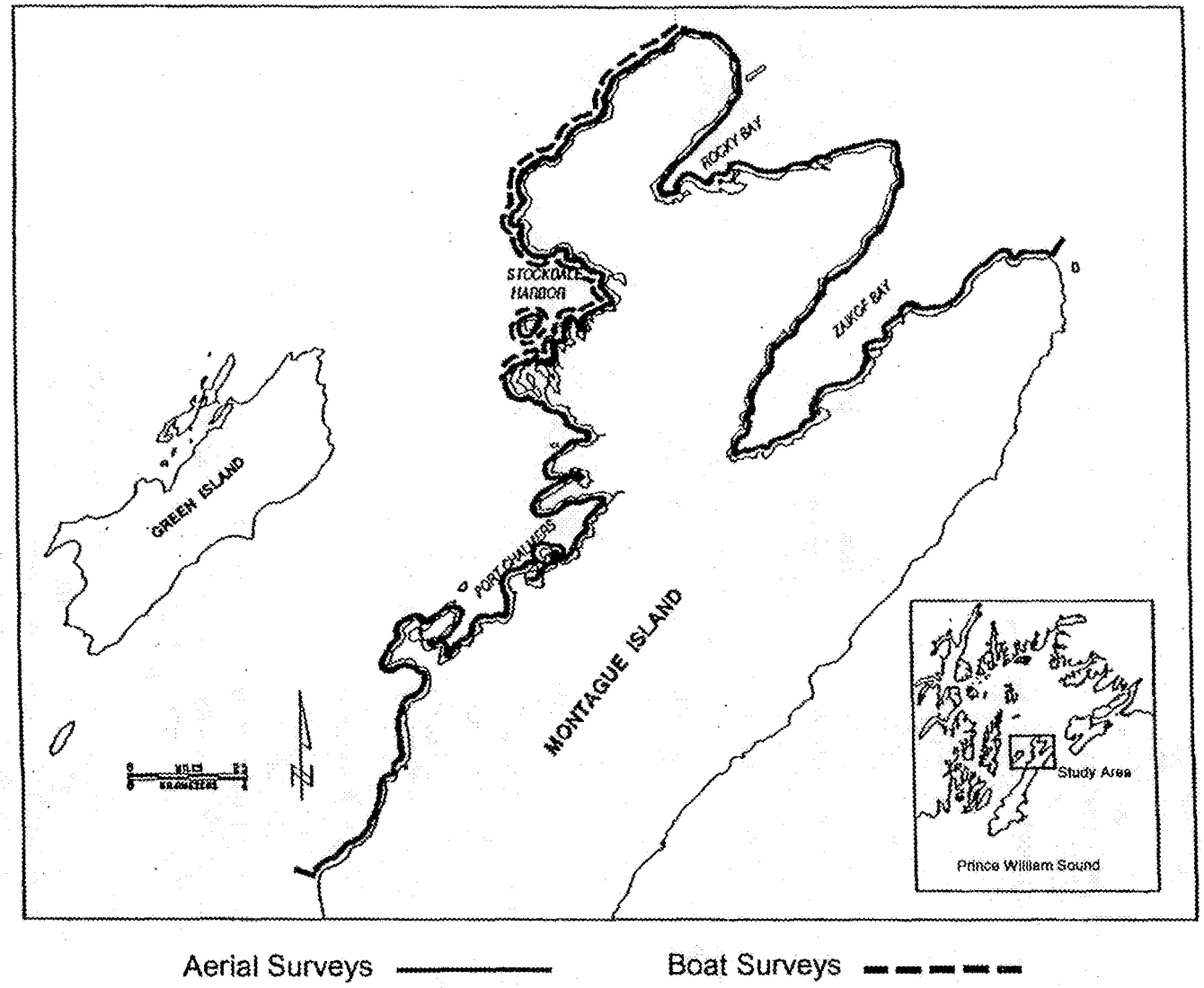

Figure 1. Map of Northern Montague Island intensive study area showing aerial (solid line) and boat survey areas (dashed line). Avian Predation on Herring Roe Project, Spring 1994.

approximately 5 knots. While the boat is moving along the transect, all birds are counted within the space that extends 100m on each side, 50 m ahead, and 100m above the boat. One observer will be assigned to survey from the boat to shore, and the other from the boat seaward 100m. Data will be recorded on tape recorders and transcribed upon return.

Black turnstones and surfbirds are cryptic shorebirds and difficult to observe from a distance. Therefore, as soon as migrant shorebirds are detected in the intensive study area (projected date 20 April), shorebird surveys of the intertidal zone will be conducted from a boat moving 20m parallel to the shore. Shorebird transects will be conducted immediately following the completion of the 200m wide transect for each shoreline segment.

A sampling effort for numbers and species composition of potential avian predators will be conducted in other spawn areas of the Sound in conjunction with ADF&G spawn deposition and egg loss surveys. Depending on initiation of spawning, between approximately 1 April and 15 May, ADF&G will conduct an estimated 50-100 transects for egg densities within 5-10 days of initial spawn deposition. An additional 20 transects (10 at northern Montague Island, five at northern PWS) will be sampled every 3-4 days until hatching to determine egg loss. At northern Montague Island, egg-loss transects will include exclosures to prevent bird predation. At each of three depths along the transect line, three exclosure frames will be secured to the bottom including a coarse-meshed net exclosure, a fine meshed net exclosure and a control exclosure frame without netting.

One observer from this study will accompany the ADF&G crew throughout the Sound on their spawn deposition and egg loss surveys. As the ADF&G dive boat approaches the shoreline starting point for their underwater surveys, the observer (located in the boat) will survey a 100m wide x 300m long transect perpendicular to the shoreline. While most locations will be sampled only once, transects surveys at ADF&G egg loss sites will be conducted every 3-4 days in order to document changes in avian abundance and species composition as they relate to egg loss.

Aerial Surveys. Aerial surveys for seaducks and seabirds will be conducted before herring spawn deposition, beginning approximately 1 April until egg hatch around 20 May. Aerial surveys will cover nearshore areas at northern Montague Island from Port Chalmers to Zaikof Bay (Figure 1, pg. 6). Whenever possible, aerial surveys will be conducted on the same day as boat surveys on northern Montague. Surveys will be flown in a Cessna 185 float plane at a height of approximately 95m and at an airspeed of 90 knots. Surveys will be flown during low tide, approximately 200m from the shoreline. For protected bays where seaducks and gulls tend to use waters farther from the shoreline (e.g. Stockdale Harbor, Rocky and Zaikof Bays), multiple flight lines will be flown for complete coverage.

Two observers, one seated on each side of the plane will tape record locations and numbers of all birds seen. Birds will be identified as gulls, scoters, oldsquaws, and

other. Any identifiable flocks of shorebirds will also be noted, although no attempt will be made to survey for surfbirds and turnstones due to their cryptic coloration, and their tendency to not flush at airplanes (B. Gill, USFWS Anchorage, pers. comm.).

Foraging Ecology. Foraging ecology will be determined from scan and focal animal samples, as well as an analysis of diets. KOWA Spotting scopes will be used for behavioral observations. Field observations will be recorded directly into a hand-held computer and the data uploaded daily to laptop computer, and backed up on disks.

Scan samples (Altman 1974) across flocks will provide information on distribution and activity of birds in high density spawn areas. At northern Montague Island two habitat types with high densities of spawn will be sampled: exposed, low gradient shoreline and protected, low gradient shoreline. For each habitat type, one designated plot that includes both intertidal and subtidal zones will be scanned for birds every 30 minutes over a 12 hour period (2 tidal cycles) every 4th day. Activity classes include feeding, sleeping/resting, preening, agonistic interaction, and unknown. Feeding subclasses will be by substrate. Locomotion classes include swimming, flying, stationary, walking, diving, and unknown. Habitat location will be ascribed by substrate and meters above or below the tideline.

To document activity budgets of avian predators, a series of focal-animal samples (Altman 1974) will be gathered at both ADF&G egg density transect sites and the northern Montague Island study site. Individual gulls, surfbirds, and black turnstones will be randomly selected. Each sample period (data point) will be for 15 minutes or until the bird becomes unobservable. Behaviors will be continuously recorded onto a hand-held computer. Depending on the species, behaviors recorded will include: search, peck, handle, and rest. Whenever possible, prey species will be recorded.

Bird diets for the intensive study area will be documented by collecting (shotgun or rifle) a target of 30 individuals of the following species: glaucous-winged gull, mew gull (Larus canus), surfbird, black turnstone, oldsquaw (Clangula hyemalis), and surf scoter. An additional 30 glaucous-winged gulls will be collected around the 100x300m transects associated with the ADF&G egg density transects. Collection of each individual will be random, however birds must have been observed foraging for at least 5 minutes. Sampling effort will be proportional to the spatial distribution of each species across the intensive study area. Collection schedule for each species will be: 5 during the first 5 days of spawn, 20 during the next 10 days, and 5 during the last 5 days.

For each specimen, date, time, tidal stage, shoreline type, and habitat will be recorded. Each bird will be weighed and the wing cord measured. Esophagus and proventriculus will be removed and immersed in a preservative in a polyethylene jar. A sample of the pectoral muscle will be collected and placed in an anti-oxidant chemical in a glass jar. Sex will be ascertained during dissection. Examples of prey items (herring eggs, mussels, barnacles, limpets) will be collected for reference and for lipid analysis.

c. Data analysis

Using data from aerial and boat surveys, phenology of spawn use by avian predators will be graphically represented by plotting relative abundances by both calendar date and location. A regression analysis will be performed to determine the relationship between bird abundance, habitat type, incubation stage of spawn, and estimated biomass of herring spawn (biomass provided from ADF&G aerial survey data). Wave height and wind speed will be used as covariates.

Density, species richness and species diversity will be determined from the perpendicular 100 x 300m transect data collected in association with the ADF&G egg density transects. Results will be related to geographic location, average spawn density and extent, and egg losses as determined from the ADF&G egg density transects. For all boat surveys, significant differences between shoreline type and bird numbers will be tested using analysis of variance.

Scan samples will be used to determine the proportion of each species foraging in relation to tidal height, intertidal habitat, and egg density (where available from ADF&G). A simple regression will be fitted to illustrate trends for each species. Paired t-tests will be used to compare activities between the 2 shoreline types.

Focal animal behavioral data will be averaged for each tidal cycle and location. We will use a multivariate approach to ascertain the effects of weather and habitat (eg., principle component analysis or multiple regression). Simple linear regression analysis will be used to detect the effects of tidal height and density of spawn (data obtained from ADF&G transects).

Analysis of esophageal and proventricular contents will be conducted at the University of Alaska - Fairbanks. Two measures will be used to describe the importance of prey types in the diet: frequency of occurrence and relative weight of prey items. Weight will be expressed as percent of wet weight aggregated over all taxa and all samples. Differences in frequency of use of foods among habitats will be summarized as contingency tables and tested with G-statistics (Sokal and Rohlf 1981). A subsample of herring eggs from every 10th gut, and 4 replicate samples from every 20th gut will be dried, counted and weighed. Total number of eggs consumed per bird will be estimated from these samples.

Analysis of lipid content of tissue samples and prey items will also be conducted by the University of Alaska - Fairbanks. Lipid content in samples will be determined using high performance liquid chromatography. Lipid signatures of tissues and prey items will be compared to determine relative importance of prey items in the diet.

d. Alternatives

Live capture and forced regurgitation was considered as an alternative to collecting the entire bird. This was deemed impractical due to capture difficulty and time constraints. Carbon and nitrogen stable isotope analysis was considered as an alternative to lipid

signature analysis. Isotope analysis is more appropriate, however, when trying to determine the trophic level of prey items.

5. Location:

Field research will be conducted within the confines of PWS. Exact locations will depend upon the distribution of spawning herring. For the first year, northern Montague Island will serve as an intensive study site. Laboratory analyses will be conducted at University of Alaska-Fairbanks. Data analysis will be conducted at the Copper River Delta Institute, U.S. Forest Service in Cordova, Alaska. Data will be integrated with data management and modeling efforts for the SEA Plan as coordinated by the Prince William Sound Science Center in Cordova.

6. Technical Support:

Laboratory processing of esophageal and proventricular contents and lipid analysis will be completed at the University of Alaska-Fairbanks with projects funds. Herring egg densities and egg loss samples from ADF&G diver surveys will be processed by ADF&G. Aerial surveys on extent of herring spawn will be conducted by ADF&G. Results from both of these efforts will be made available to this study for further analysis. Data will be archived by project staff in accordance with standardized procedures set up for handling the SEA Plan database.

7. Contracts:

Aerial surveys will be a sole-source contract with Fishing and Flying in Cordova Alaska. Currently this is the only flying service in Cordova with a small (4-passenger) float plane that is approved for use by the US Forest Service. Biometric support is not currently available within the Copper River Delta Institute to support data analysis. This work will be therefore be subcontracted. Analysis of gut samples collected for diet analysis, including lipid analysis will be contracted through the University of Alaska-Fairbanks. The complexity of procedures and the specialized equipment needed to conduct analyses necessitate an outside contract.

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D. SCHEDULES

1. Milestones

FY 1994

March 1-April 4	Logistical planning and safety training
April 4-May 20	Field data collection
May 21-August 21	Data entry, data analysis, and diet analysis
August 22-October 31	Draft 1994 report writing and internal review

FY 1995

November 1	Draft report submitted for peer review
January 1	Peer review comments returned to USFS
February 15	Final report submitted for peer review

2. Project Personnel

Project Manager, Fred Everest (Pacific Northwest Research Station, Juneau Forestry Sciences Laboratory): Ensures that project deadlines are met by the project leader.

Project Leader, Mary Anne Bishop: Oversees the project and coordinates with other members of the SEA Plan, and the ADF&G herring spawn deposition study. Is responsible for project design, contract management, data analysis and completion of final products and data integration into SEA plan ecosystem models. Will conduct aerial surveys. Will also act as office liaison for field supervisor.

Assistant Project Leader and Field Supervisor, S. Patrick Green- During the field season wil be responsible for planning, data and specimen collection and logistics in the field. Responsible for purchasing equipment and organizing safety training for crew. Post season duties include data compilation, and analysis.

Bio Tech 1: Will assist in field preparation. Will accompany ADF&G spawn survey deposition study crew. Will conduct perpendicular shoreline surveys and focal bird samples. Will collect 30 glaucous-winged gulls for diet analysis.

Bio Tech 2 & 3: Will assist with data and specimen collection in the field and equipment maintenance.

3. Logistics

a. Field camps

A field camp located between Stockdale Harbor and Montague Point will be required for collecting data in the intensive study area If herring spawn distribution warrants a change to Rocky Bay, the Forest Service administrative cabin in Rocky Bay will be used as the field camp.

b. Vessel Support

Cordova Ranger District's vessel (Chugach National Forest) will provide transportation and supplies to and from the field camp on Montague Island. At the field camp, a 17' Boston whaler with 90 hp motor is needed to conduct shoreline surveys, and collect all other data. ADF&G has agreed to provide the 17' boat. One outboard motor-equipped inflatable raft will be used as a back up.

c. Small plane

A small float plane (Cessna 185) will be required to conduct aerial shoreline surveys on northern Montague Island.

E. EXISTING AGENCY PROGRAM

No federal or state agency program currently exists that could be described as an ecosystem framework for studying resources in Prince William Sound and the EVOS region. For the first seven months (FY94) of the bird avian predation component of the SEA field program, the Copper River Delta Institute will contribute resources in the form of personnel costs for the Project Leader (3.5 months) and Assistant Project Leader (1 month) as well as some field equipment (one inflatable skiff with motor and camping supplies). Ongoing spring shorebird migration studies on the Copper River Delta will provide additional information on the phenology and habitat use of surfbirds and black turnstones.

Other agency contributions to this project include equipment loans from the Cordova Ranger District, Chugach National Forest: one weatherport, one wall tent, and access to their administrative cabin at Rocky Bay. The US Forest Service will also make available for a minimal daily charge their 27' Boston Whaler to transport personnel and equipment to the study site at Montague Island. The ADF&G Habitat and Restoration division will provide a 17' boston whaler throughout the April-May field season at Montague Island. Costs for whaler modification required by this project will be covered under this budget.

F. ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS

This study primarily involves observations and infrequent collection of birds. A scientific collecting permit has been applied for with the US Fish and Wildlife Service to collect the gulls, waterfowl, and shorebirds. A decision should be rendered by the end of March. This study qualifies for a categorical exemption from the requirements of the National Environmental Policy Act.

G. PERFORMANCE MONITORING

1. Backup Strategy

In the event that the Project Leader, Mary Anne Bishop leaves before the project's completion, Robert Gill, Research Biologist at National Biological Survey in Anchorage will take on the analysis and writing responsibilities.

2. Quality Assurance and Control Plan.

Quality control will be accomplished by thoroughly training biological technicians for the shoreline surveys, the basic sampling method. Additionally, the assistant project leader will have been previously trained by USFWS in their shoreline survey techniques. All personnel will have previous experience in identifying shorebirds, seabirds, and seaducks. Training will emphasize flock size and distance estimation. Flock size estimation training will rely on computer programs especially designed for bird number estimation, slides of flocks with known numbers of birds, and practice before field work begins.

Field personnel will use aerial photographs and maps to record the locations. All data taken on hand-held tape recorders during shoreline surveys will be transcribed by the observer as soon as possible into the computer and checked by the field supervisor. Data taken on hand-held computers during scan and focal animal foraging samples will also be field-checked by the field supervisor.

H. COORDINATION OF INTEGRATED RESEARCH EFFORT

All aspects of field work for this project are coordinated with the Alaska Department of Fish and Game Herring Spawn Deposition study, (EVOS Project 94166). The herring spawn deposition study will provide a berth aboard their charter vessel and daily transportation to their sampling sites for one biological technician. The 100x300m perpendicular shoreline transects and some focal-animal sampling will be conducted in conjunction with ADF&G egg density transects. In addition, ADF&G will provide herring egg densities and egg loss results from ADF&G diver surveys and information on the timing and extent of spawn documented from ADF&G aerial spawn surveys.

All data from this project will be archived by the project staff in accordance with standardized procedures set up for handling the SEA Plan database. The field results from the avian predation study will be integrated into the SEA plan's numerical and analytical models of the PWS ecosystem that include predation parameters and animal distributions.

In that this study is scheduled to continue for 5 years, we will continue to coordinate with the Herring Spawn Deposition study as much as possible. Next year, we will also coordinate with the SEA Plan's Herring Larval Study scheduled to begin in FY95.

I. PUBLIC PROCESS

Sound Ecosystem Assessment (SEA) is an ongoing project with a mission to develop and advocate the best model for ecosystem research in Prince William Sound and the EVOS affected region. The concept of the SEA program has been in the region for several year, however only since August of 1993 has the plan been under intense

development and come to fruition as a working document for guiding ecosystem level research in PWS and the EVOS region. The SEA Science Group consists of Scientists and Managers from the University of Alaska, Alaska Department of Fish and Game, PWS Science Center, PWS Aquaculture Corporation and the US Forest Service. There has been a tremendous amount of public input into the formulation of this project. Input has been received from Prince William Sound Communities Organized to Restore the Sound (PWSCORS), Cordova District Fisherman United, Cordova Aquatic Marketing Association and numerous Prince William Sound fisherman. A workshop sponsored by the EVOS Trustee Council and NOAA was held in Cordova Alaska during December of 1993 to peer review the SEA document and to further plan for coordinated and integrated ecosystem research in Prince William Sound and the greater EVOS affected region.

J. PERSONNEL QUALIFICATIONS

1. Project Leader - Mary Anne Bishop

Dr. Mary Anne Bishop received a B.B.A. from University of Wisconsin in 1974, a M.S. in Wildlife and Fisheries Sciences from Texas A & M University in 1984, and her Ph.D. in Wildlife Ecology from the University of Florida in 1988. Dr. Bishop has studied the ecology of cranes since 1980, including behavior and movements of subadult whooping cranes (Grus americana), breeding biology of Florida sandhill cranes (Grus canadensis pratensis), and wintering ecology of black-necked cranes (Grus nigricollis) in China. Since 1989, Dr. Bishop has worked for the Pacific Northwest Research Station of the U.S. Forest Service including since April 1990 as the research avian ecologist with the Copper River Delta Institute in Cordova Alaska. Bishop also served as the Institute's Acting Manager from May 1992 through April 1993. She is the Principal Investigator for a study on the migration ecology of shorebirds on the Copper River Delta. Additionally, she is the co-principal investigator of a study on spring and fall staging behavior of trumpeter swans (Cygnus buccinator)on the eastern Copper River Delta. In February 1994, Dr. Bishop along with Chris Iverson of the Tongass National Forest won the U.S. Forest Service's Taking Wing National Award for Research. This award was for their cooperative study on the spring migration ecology of western sandpipers on the Pacific coast. Dr. Bishop has presented numerous papers at national and regional meetings.

Relevant reports and publications:

Iverson, G.I., S. Wornock, N. Wornock, M.A. Bishop, R.W. Butler. in prep. Migration time and linkages between shorebird stopover areas.

Bishop, M.A. and S.P. Green. 1992. Shorebird migration on the Copper River Delta. Final rept. to U.S. Fish and Wild. Serv. Interagency Agreemt. No. 91-0085. Cordova, Alaska. 30pp.

Bishop, M.A. and P.S. Green. 1992. Shorebird migration on the Copper River Delta: report on the 1991 spring and fall migration. FY-91 year-end rep. U.S. Fish Wildl. Serv. Interagency Agreemt. No. 91-0085. Cordova, Alaska. 20pp.

Bishop, M.A., K.M. Portier, and M.W. Collopy. 1991. Sampling methods for aerial censuses of nesting Florida sandhill cranes in central Florida. Pages 235-239 in J. Harris, ed. Proc. 1987 Int. Crane Workshop.Int. Crane Fdtn., Baraboo, WI.

2. Assistant Project Leader & Field Supervisor - S. Patrick Green

S. Patrick Green received his B. Sc. in Wildlife Resources from West Virginia University in 1990. Since 1990 he has worked for the U.S. Forest Service first as a technician and then as a field supervisor at the Copper River Delta Institute in Cordova Alaska. For the past 3 years, he has been involved with the Copper River Delta Spring shorebird ecology study both in the field and as a data analyst. Patrick also participated in a study on Trumpeter Swans foraging ecology as a Field technician and a Field camp supervisor. In addition he has worked on Eastern deciduous forest passerines, on field contaminants and their effect on passerines, and worked for the National Audubon Society studying Roseate Spoonbill breeding and foraging ecology.

3. Project Manager - Fred Everest

Fred Everest is the Program Manager for the Aquatic/Land Interaction program of the Pacific Northwest Research Station, U.S. Forest Service. The Copper River Delta Institute and its research program is a major component of the Aquatic/Land Interaction program.

K. BUDGET

The budget for this subproject of the SEA Plan is attached. FY94 costs are for a 7-month (March-September 1994) fiscal year. FY95 increase reflect a scaling-up of the project for including an additional field crew.

Project [redacted] AVIAN PREDATION ON HERRING SPAWN

Budget Category	Proposed 01-Mar-94 30-Sep-94		FY 95	FY 96	FY 97	FY 98	Sum FY 99 & Beyond
Personnel	$27.6		$77.4	$77.4	$77.4	$77.4	$30.0
Travel	$0.0		$1.6	$1.6	$1.6	$1.6	
Contractual	$24.5		$28.1	$28.1	$28.1	$28.1	
Commodities	$9.4		$13.5	$10.5	$10.5	$9.5	
Equipment	$15.0		$35.2	$2.6	$2.6	$0.5	
Capital Outlay	$0.0		$0.0	$0.0	$0.0	$0.0	
Sub-total	$76.5		$155.7	$120.2	$120.2	$117.1	$30.0
General Administration	$8.5		$17.3	$13.4	$13.4	$13.0	
Project Total	$85.0		** $173.0	$133.5	$133.5	$130.1	$30.0
Full-time Equivalents (FTE)	1.1		1.7	1.7	1.7	1.8	0.6

Budget Year Proposed Personnel:

Position	Months Budgeted	Cost	Comment
Research Wildlife Biologist	3	$15.0	Project Leader, 2.3 months of cost in-kind
Wildlife Technician	4	$10.8	Assistant Project Leader & Field Supervisor, 1 month of cost in-kind
Wildlife Technician	2	$5.4	Conduct boat surveys and behavioral observation
Wildlife Technician	2	$5.4	Conduct boat surveys and behavioral observation
Wildlife Technician	2	$5.4	Conduct boat surveys and behavioral observation
Total		$42.0	

** FY 1995 Project Total includes a second field crew, additional commodites and equipment for second crew, and a 17' Boston Whaler (in addition to the whaler on loan from ADF&G). Project expansion allows for full coverage of northern Montague Island which is critical to understanding the ecology of avian species foraging on herring roe in the study area.

Travel:	none	
Contractual:	Air charter ($14,400) - for aerial surveys Anaylsis of stomach contents ($3600,240 stomaches at $15/stomach) Analysis of lipid content ($2,500, 30 samples at $80 a sample)	
Commodities:	Supplies for field camp ($3,300)	$3,289.85
	Scientific supplies ($1000)	$1,010.00
	Field sampling supplies ($3,500)	$3,515.00
	Boat supplies and maintenance ($1600)	
Equipment:	Optics ($5000) - includes binoculars and spotting scopes Computer and software ($8000) - includes a computer for data analysis and software programs and interface for field dataloggers Communications($1100)	

FY 1995 Project Total includes a second field crew, additional commodites and equipment for second crew, and a 17' Boston Whaler (in addition to the whaler on loan from ADF&G). Project expansion allows for full coverage of north Montague Island which is critical to understanding the ecology of avian species foraging on herring roe in the study area.

United States Department of Agriculture
Forest Service
Pacific Northwest Research Station/ Alaska Region
Copper River Delta Institute
P.O. Box 1460
Cordova, AK 99574
(907) 424-7212
FAX (907) 424-7214

Caring for the Land and Serving People

Bob B. Spies, Chief Scientist
Exxon Valdez Restoration Trustee Council
645 G Street
Anchorage, AK 99501

Date: 23 February 1994

Dear Dr. Spies:

Attached please find the Avian Predation on Herring Spawn detailed project description. I would like to suggest that Stan Senner and Jake Schweigert be the two reviewers for this project. Below are their addresses.

Stan Senner
Migratory Bird Conservation Program
National Audubon Society
4150 Darley Avenue, Suite 5
Boulder, CO 80303
phone (303)499-7855; fax (303) 499-0286

Jake F. Schweigert
Dept. Fisheries & Oceans
Pacific Biological Station
Hammond Bay Road
Nanaimo, B.C. V9R 5K6 CANADA
phone (604) 756-7203; fax (604) 756-7138

I look forward to receiving the peer review comments. Thank you very much.

Best wishes,

Mary Anne Bishop

Mary Anne Bishop, Ph.D.
Project Leader - Avian Predation on Herring Spawn

Enc..
cc: Jim Ayers, Executive Dtr.
EVOS Restoration Trustee Council

R. Ted Cooney, Science Chair
SEA Plan

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A. COVER PAGE

PROJECT TITLE:	Disease Impacts on Prince William Sound Herring Populations
PROJECT ID NUMBER:	94320-S
PROJECT TYPE:	Research/Monitoring
NAME OF PROJECT LEADERS:	David Hinton, Gary Marty, Theodore Meyers and John Wilcock
LEAD AGENCY:	Alaska Dept. of Fish and Game
COST OF PROJECT, FFY 94:	$97.0 K
COST OF PROJECT, FFY 95:	$25.0 K
PROJECT STARTUP DATE:	April 20, 1994
PROJECT COMPLETION DATE:	Sept. 30, 1994
GEOGRAPHIC AREA OF PROJECT:	Prince William Sound

NAME OF PROJECT LEADER:

David Hinton _____ Date _____

NAME OF LEAD AGENCY PROGRAM MANAGER:

Joseph R. Sullivan _____ Date _____

B. INTRODUCTION

Prior to the 1993 herring spawning season, 134,000 tons of herring were forecast to arrive on the spawning grounds of Prince William Sound (PWS). Significantly less than half that amount appeared. Skin lesions, typically ulcerated, were seen on one-sixth to almost one half the herring in almost every school (except northeastern PWS). Viral hemorrhagic septicemia (VHS) was isolated from these herring but it was not determined whether this virus was the cause of the poor returns and apparent disease or simply a secondary infection in fish which were already in poor health for another unknown reason. Nevertheless, the virus which causes VHS was the only pathogen isolated. In 1994, it appears that only 20,000 tons of herring arrived at the spawning grounds. Spawning occurred over an unusually small area, many ovaries were degenerate and the lesions, never a reported feature of the spawning population prior to 1993, were also abundant this year. Though human induced large mortalities of fish commonly occur in many places, natural epizootics of this magnitude are very rare. Herring are very long lived fish (to 15 years), and, in the absence of catastrophic events, dramatic population declines should not be expected. VHSV is a very poorly understood pathogen. It has the potential to infect many species of bony fishes (fish other than sharks and rays), but its ability to produce disease varies from species to species and strain of virus. For example, salmon may be carriers without experiencing observable effects, but rainbow trout in European hatcheries suffer severe mortalities when exposed to the Egtved strain of VHSV. Attempts to produce the disease in Atlantic cod with VHSV isolated from other cod were not successful.

Significant declines in marine birds and mammals which eat forage fish have been reported from Prince William Sound. Decline in prey base, of which herring constitute a major portion, has been implicated in the decline in bird and mammal numbers. Thus, a major reduction in herring numbers in Prince William Sound has the potential for significant impacts throughout the ecosystem. It is incumbent upon the Trustee Council to investigate circumstances which could seriously limit the recovery of species injured by the Exxon Valdez oil spill. Collapse of the herring population has that potential.

C. PROJECT DESCRIPTION

In 1994, it is important to investigate whether VHSV may play a role in the apparent decline in the herring spawning population and to determine the magnitude of this effect. We propose a study which will examine general condition and spawning condition of the herring and compare these measures of overall health to the incidence of VHS virus infection and the clinical signs associated with it. This should indicate whether VHS is the cause or a byproduct of the decline in the health of the herring population and determine the magnitude of the effect. Historical data available on growth rate and lipid content in overwintering adult herring and associated physical conditions will be compiled. An analysis of historical data may provide clues to the events leading up to the run failures in 1993 and 1994.

1. **Resources and/or Associated Services:** Prince William Sound Pacific herring (*Clupea pallasi*). Pacific herring support five commercial fisheries in PWS with an annual average ex-vessel value of $8.3 million. Pacific herring provide important forage for many species including some species severely injured by the Exxon Valdez oil spill. Predator species include humpbacked whales, seals, sea lions, gulls, sea ducks, shore birds, halibut, salmon, rockfish and other fish. In addition, several thousand pounds of herring and herring spawn on kelp are harvested annually for subsistence purposes and form an important part of the local native culture of Chenega and Tatitlek.

2. **Relation to Other Damage Assessment/Restoration Work:** This project was added to 94320, the Prince William Sound System Project, because major fluctuations in the population size of Prince William Sound herring may have a domino effect on many of the other injured resources in Prince William Sound. Reduction of the herring population to as little as15% of expected returns cannot fail to have a significant impact on those resources for which herring were a major component of their diet. Understanding the population dynamics of herring in PWS will be well addressed by this subproject (94320-S, the impacts of diseases) in conjunction with many other projects and subprojects of 94320. Herring spawn deposition and reproductive impairment (94166) addresses several aspects of reproduction and recruitment. Herring genetics (94165) determines the detectability of more than one stock in PWS. Zooplankton in the ecosystem (94320-H) determines what is available for herring to eat. Forage fish (94163) and avian predators (94320-Q) examine the relationship between herring and what feeds on them. Most other parts of 94320 also provide some information on the factors which affect herring populations as well as other parts of the Prince William Sound ecosystem. Synthesizing the results of all of these projects and subprojects should well document the reasons for major changes in herring population size and structure.

3. **Objectives:**

   (i) Assess the general health of Prince William Sound herring.

   (ii) Investigate the impact of disease on population size and structure of Prince William Sound herring. Are herring of a particular year class more likely to be diseased than other year classes?

   (iii) Assess the primary or secondary invader role of Viral Hemorrhagic Septicemia virus (VHSV) in producing disease in Prince William Sound Pacific herring.

   (iv) Assess the influence of disease on the spawning potential of herring and, conversely, the impact of spawning and other stressors on herring health.

4. METHODS: To best characterize the condition of herring in Prince William Sound during the 1994 spawning season, herring were sampled for several types of analyses. At least 450 herring from each of two locations (Rocky bay and Stockdale harbor) were to be sampled for weight- and length-at-age characteristics (AWL). A subsample of these AWL herring were to be examined for health assessment with particular focus on viral hemorrhagic septicemia. However, the opportunity to sample two locations was lost before this subproject could reach the field. Therefore, of the AWL samples taken from Rocky Bay on Montague Island, from April 22 through April 26, 1994, 233 herring were examined for health assessment and were subjected to complete necropsy. Because herring from Rocky Bay comprised over 70% of the 1994 spawning population, this sample should be adequate to characterize the spawning population. Also, by the time sampling began, herring were no longer available from the other significant 1994 spawning site in PWS: Stockdale Harbor, also on Montague Island. Herring were sampled throughout each sampling day by gill net or purse seine. To minimize capture effect, herring were held no longer than four hours before necropsy, and necropsies were done on anesthetized herring aboard the *R/V Montague* anchored in Rocky Bay. Health assessment was constrained to 233 herring because this was the total number of herring which could be examined before weather and dispersal of the herring forced a conclusion to the field portion of this study. Herring were randomly selected for necropsy. Abnormal fish were sufficiently common that random selection nevertheless resulted in both normal and abnormal herring being examined.

Each herring was visually screened for external lesions, five of which were semiquantitatively ranked as none (0), mild (1), moderate (2), or severe (3). Scored lesions included caudal fin fraying, caudal fin reddening, fin base reddening, focal skin reddening, and iris reddening. Each herring was assigned an overall external lesion score: 0 (no significant lesions), 1 (mild), 2 (moderate), or 3 (severe). Measurements on each herring included body weight, standard length, age (from scales), liver weight, and gonad weight. Otoliths were archived for later use if information on annual growth rates is desired.

During the necropsy, samples were taken for several types of analysis (listed in order of priority):

a.) Virus isolation - Spleen and anterior kidney were placed on ice in Whirl-pak bags; severe skin lesions were also sampled and placed on ice in a second Whirl-pak bag. Tissues were sent to the Alaska Department of Fish and Game's Fish Pathology laboratory where they will be homogenized and serial dilutions inoculated onto cultures of *Epithelioma papulosum cyprini* (EPC) cells and incubated at 15°C for fourteen days. Cultures not demonstrating cytopathic effect (CPE) will be blind-passed and incubated for another fourteen days.

b.) Histopathology - Gill, spleen, liver, gonad, heart, stomach, intestinal tract, kidney, skeletal muscle/skin, brain, and any gross lesions not otherwise sampled were fixed in 10% neutral buffered formalin. Tissues will be processed

routinely in paraffin, sectioned at 5 μm, and stained with hematoxylin and eosin for analysis of microscopic lesions. Also, sections of ovary will be morphometrically analyzed for oocyte stages.

c.) Hematology - Blood was drawn from the caudal vein into a heparinized syringe. Packed cell volume (PCV) and total protein were determined on site, A smear was made for analysis of erythrocyte morphology to rule out Viral Erythrocytic Necrosis (VEN). Plasma was frozen for analysis of total protein, albumin, osmolarity, and plasma chemistries (ALP, ALT, AST, CPK, GGT, sodium, potassium, chloride, phosphate, bicarbonate (CO_2), calcium, cholesterol, glucose, and total bilirubin). Erythrocytes remaining after plasma was decanted were frozen and archived, but type of analysis has not been determined.

d.) Bacteriology - A touch prep of anterior kidney from each herring was made on a glass slide. For each herring with moderate or severe gross lesions, a sterile loop was stabbed into the anterior kidney and then streaked on Trypicase Soy Agar (TSA). The TSA plate was held at room temperature for bacterial isolation.

e.) DNA-adduct formation - Liver (0.1-0.2 g) was frozen and archived in 1.5 mL Eppendorf tubes. Analysis will occur only if indicated by results from virus isolation, histopathology, and hematology. DNA adducts can be detected up to 6 months after exposure to xenobiotics, and this test has the greatest potential for linking toxicant exposure to herring morbidity.

f.) Proximate analysis or Lipid analysis - A wedge of body musculature in the region of the dorsal fin was frozen and archived in a Whirl-pak bag. Previous studies of lipid content of spawning herring have consistently found lipid levels in the range of 2%; therefore, differences in lipid content are not likely to be detectable and this analysis is of low priority.

g.) Cytochrome P450 induction - Liver (0.1-0.2 g) was frozen and archived in 1.5 mL Eppendorf tubes. Analysis will be done using an ELISA technique, only if indicated by other results. Previous studies indicate that herring do not activate cytochrome P450 during the spawning season, so these analyses are of low priority.

h.) Fluorescent aromatic compounds - The gall bladder was evacuated into a sterile 27-gauge needle on a 1-mL syringe and bile was decanted into a glass vial and frozen. A sample of gonad, up to 10g, was put into a glass scintillation vial and frozen.

i.) Genetic analysis - Liver (0.1-0.2 g) was frozen and archived in 2.0 mL cryogenic tubes. These samples were taken at the request of Jim Seeb, Alaska Department of Fish and Game, and the type of analysis has not been determined.

To more fully characterize the spawning population, additional herring were sampled for age, body weight, standard length, and gonad weight (AWL measurements) as well as presence or absence of external lesions (focal skin reddening). These herring were not subjected to complete necropsy and were not examined by the pathologists.

Results from virus isolation will be reported as a VHSV titer. Results from analysis for viral erythrocytic necrosis (blood smear) and histopathologic analysis will be reported for each lesion, semiquantitatively ranked on a four-point scale (0,1,2,or 3) as described for gross lesions. Correlation or rank correlation matrices of these and the routine AWL measurements will be examined as an initial screening for measures associated with the disease. Appropriate data transformations will be investigated if parametric procedures are used. Analysis of covariance will be used to test for the significance of associations between the various measurements (e.g., virus titer, serum chemistries) and lesion scores. Particular attention will be given to the independent variable age (or year class) in these analyses, because each year class of herring has a different exposure history to oil. Age effects will be examined both as a covariate (for cumulative life history effects), and as a classification variable, for specific year class effects.

5. Location: Rocky Bay, Prince William Sound.

6. Technical Support: The Alaska Department of Fish and Game's Fish Pathology Laboratory (Juneau) will process samples for viral hemorrhagic septicemia virus isolation, viral erythrocytic necrosis identification (blood smear), and bacterial isolation. The Aquatic Toxicology Laboratory, University of California, Davis, will perform the histopathology. Med Veterinary Laboratory, Concord, California, will do the hematology. The Alaska Department of Fish and Game Cordova office staff will determine herring age, summarize AWL information, and provide initial data entry. Other samples will be archived for analysis if warranted at a later date.

7. Contracts: Drs. David Hinton and Gary Marty, University of California, Davis will be project investigators and the UC Davis laboratory with which they are associated will process the histopathology, and lipid analysis. Contracts with the investigators and a cooperative agreement with their laboratory will be established. Drs. Hinton and Marty and the UC Davis laboratory provided histopathology services for the Trustee Council's NRDA fish studies, including herring, and therefore have invaluable prior experience. Further, this project was created under essentially emergency circumstances in response to a second year of unpredicted and cataclysmic herring population declines that appear to be associated with an epizootic (VHS). Because there was a very short window of opportunity (estimated at two weeks during near-shore schooling for spawning) in which to collect these samples, an investigator was needed immediately who would require little or no training in collecting standard fisheries, virology, histopathology, and blood chemistry samples. Dr. Marty has both the required pathology (D.V.M. with emphasis on fish) and fisheries background (B.S., M.S. in fisheries science) and was available on short notice to collect the samples and to proceed with this project. Dr. Hinton also has a fisheries and veterinary background, supervises Dr. Marty and is director of the UC Davis Fish Pathology

laboratory.

Vessel and air charter support will be needed to collect samples. The ADF&G *R/V Montague* will be available at an estimated cost of $1,000/day. Air charters will be arranged using Cordova area vendors at previously established state rates.

Blood chemistry samples will be processed by Med Veterinary Lab of Concord, California.

D. SCHEDULE

DATE	ACTIVITY
April 19-21, 1994	Plan field activities, arrange sampling protocol and logistics, gather field materials.
April 22-26	Field sampling
April 25-May 30	Virology (includes blind passes and laboratory report)
May 30-Sept. 30	Histopathology, blood chemistry, lipid analysis, scale and otolith analysis, blood smears, and kidney smears
Oct. 1, 1994-Jan. 31, 1995	Report writing

E. EXISTING AGENCY PROGRAM

Existing programs within ADF&G that will contribute to this project include the AWL Sampling Program and the Juneau Fish Pathology Laboratory. AWL samples used in this project will be taken and processed for a savings to the project of approximately $10.0 K. The virology blood and kidney smear samples will be processed by the ADF&G Fish Pathology Laboratory for an approximate savings of $22.0 K.

F. ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS

The National Oceanic and Atmospheric Administration (NOAA) is the lead federal agency for National Environmental Policy Act (NEPA) compliance for this project. The NOAA counsel for NEPA was contacted and it was determined that this project qualifies for categorical exclusion because it is essentially a laboratory study without environmental consequences. The samples were collected by Alaska Department of Fish and Game personnel under the authority of a scientific collector's permit issued by ADF&G.

G. PERFORMANCE MONITORING

Dr. Joseph Sullivan, Resource Program Manager for ADF&G EVOS projects, has been certified by the Fish Health Section of the American Fisheries Society as a Fish Pathologist and a Fish Health Inspector. He has extensive education and work experience in the field of fish health. Dr. Sullivan was one of the researchers who discovered viral hemorrhagic septicemia virus in Prince William Sound Pacific cod in 1990. As program manager, Dr. Sullivan receives project reports and administers project contracts. He is capable of quality assuring valid project results. In the event of personnel change, he will pursue contracts with other fish health laboratories.

H. COORDINATION OF INTEGRATED RESEARCH EFFORT

This subproject is closely allied with many of the other subprojects of 94320 (Prince William Sound System Investigations), with Project 94166 (Herring Spawn Deposition and Reproductive Impairment), and with Project 94163 (Forage Fish Influence on Injured Species). If VHSV is a primary pathogen, a catastrophic decline in herring abundance will occur despite other environmental parameters which might be favorable and which are being investigated by other 94320 subprojects. Conversely, VHSV may also be a sign of environmental stress and merely a secondary invader. In that case it would be much less responsible for the decline in the herring population than possibly adverse environmental conditions (cf. 94320-G, Phytoplankton and Nutrients; 94320-H, Zooplankton in the Ecosystem, and 94320-M, Physical Oceanography). Demonstrating the cause of the population decline may ultimately require information from these other subprojects. The health of the herring population in Prince William Sound will impact those animals with which it competes (cf. 94163, Forage Fishes and 94320-N, Nearshore Fish) and those resources which prey upon it (cf. 94320-F, Harbor Seals-Trophic Interactions; and 94320-Q, Avian Predation on Herring Spawn). Integrated information from the herring health subproject and the spawn deposition and reproductive impairment project may be able to predict the course of recovery for Prince William Sound Herring.

I. PUBLIC PROCESS

This is the second year of herring spawning run failures apparently associated with disease. Commercial fishers believe the disease and spawning failure are a result of the Exxon Valdez Oil Spill though there is no evidence to date that this is the case. Nevertheless, commercial fishing for herring in Prince William has collapsed for the past two years. This coupled with poor returns of pink salmon in 1993 and predicted poor returns in 1994 are driving many commercial fishers to bankruptcy. The public looks to the Trustee agencies to investigate this collapse. This subproject did not follow the normal course of project development and public review because it was created to respond to an emergency situation. This is allowed in project 94320 under the Adaptive Management Process which was approved at a public meeting of the Trustee Council on April 11, 1994, a few days before the need for this herring disease subproject was apparent. Nevertheless, a representative of the Cordova District Fishermen United was present at the hastily gathered planning sessions which created this

subproject and CDFU fully supports this investigation.

PERSONNEL QUALIFICATIONS

Dr. David E. Hinton, Ph.D., Director of the ATL, will serve as principal investigator and will be in charge of project administration, integration of effort between histopathology, fish infectious disease diagnostic laboratory (Dr. R.P. Hedrick, Director), biochemical toxicologists and other aspects of the investigation. In addition, Dr. Hinton will oversee all preparation of reports.

Gary D. Marty, DVM and diplomate, American College of Veterinary Pathologists, will be responsible for on-site evaluation including, but not limited to : necropsy, design of overall pathology studies, division of samples for pathology, microbiology, serum clinical chemistry, blood chemistry, hematologic studies. Dr. Marty will also be the principal pathologist reading histologic preparations related to all fish brought to UC Davis.

Theodore Meyers, Ph.D. has been the Principal Pathologist for the Alaska Department of Fish and Game since 1985. In this position, he supervises a staff of fish pathologists and micrologists in laboratories in Anchorage and Juneau. These laboratories are equipped to provide a full range of fish disease diagnostic and pathogen broodstock screening services. Dr. Meyers and the ADF&G laboratories have been involved in the detection and diagnosis of viral hemorrhagic septicemia virus in Alaskan fishes since 1990, detecting the virus in cod and herring from Prince William Sound and in herring from other parts of Alaska.

Corrine Davis, DVM will assist Dr. Marty. Dr. Davis, a graduate of the University of California-Davis, School of Veterinary Medicine, is in the final stages of her pathology residency training and is performing PhD studies in the ATL. Dr. Davis will assist Dr. Marty in necropsy of all fish and will be the second pathologist for assessment of histopathological alterations.

Barbara Shayne Washburn, PhD, received her doctorate in nutritional biochemistry and performed postdoctoral studies at the University of Miami working with response of fish to natural biotoxins. She will perform studies evaluating condition and overall aspects of toxicity in fish. Dr. Washburn will oversee all lipid analyses and - if additional evaluations should prove desired - is prepared to conduct additional assays.

John A. Wilcock is a herring fisheries research biologist with the Alaska Department of Fish & Game, P.O. Box 669, Cordova, Alaska 99574. He received a Bachelors of Science in Fisheries from the University of Washington in 1978 and has worked as a fisheries research biologist for ADFG since 1981. He has supervised projects investigating EVOS injury to PWS herring since 1991 and was involved in the formulation of plans for project 94320, Prince William Sound System Investigations.

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94417

DETAILED PROJECT DESCRIPTION
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BRIEF PROJECT DESCRIPTION FOLLOWS

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Title: Waste Oil Disposal Facilities

Project Number: 94417

Lead Agency: ADEC

Cooperating Agency: None

Cost of Project, FY94: $232.2K **Cost of Project, FY95:** $399.5K

Project Start up Date: February 1, 1994 **Duration:** Multi-year

Geographic Area: Prince William Sound and the Gulf of Alaska

INTRODUCTION

Vessels in Prince William Sound and the Gulf of Alaska, especially in the zone affected by the *Exxon Valdez* oil spill, generate large quantities of used motor oil and other lubricants. In spite of regulations and enforcement actions to the contrary, a substantial (but unknown) amount of this waste oil finds its way into the marine environment. During the recovery phase of the spill it is desirable to eliminate additional sources of hydrocarbon contamination to the marine environment. The ports of Whittier, Homer, Seward, and Valdez all support increasingly large fleets of pleasure and recreational craft in addition to the resident and transient commercial fishing fleets. Cordova and Kodiak are seasonally among the busiest fishing ports on the West Coast. Villages such as Tatitlek, Chenega Bay, Port Graham, English Bay, and the Kodiak Island villages are home port for small-scale commercial fishing and subsistence-use vessels.

Proper disposal of used oil has long been viewed as a problem throughout the area. Handling, storage, and transportation of used oil has carried considerable cost and potential liability, especially under now-outdated federal regulations that routinely placed almost all waste oil under hazardous waste handling regulations. While some communities have waste oil collection facilities, others do not. Even at these few sites with collection facilities what to do with the waste oil once it is collected remains a major problem.

Nationwide, regulatory and financial issues have discouraged people from properly disposing of waste oil; more often than not, waste oil was illegally dumped in landfills, sewer systems, or other open sites. In 1992, the U.S. Environmental Protection Agency (EPA) estimated that 170 million of the 190 million gallons of waste oil generated in the nation found its way into the environment due to improper disposal; this represents approximately 16 times the amount of oil spilled by the *Exxon Valdez*. On August 12, 1992, EPA changed its classifications regarding waste oil recycling and disposal, eliminating many of the regulatory

disincentives frustrating the development of good waste oil handling and disposal in the nation.

The change in federal rules offers the Trustee Council an opportunity to support a project that would reduce the amount of waste oil entering the marine environment in the area affected by the *Exxon Valdez* oil spill. Reducing or eliminating other sources of hydrocarbon contamination in the spill area is desirable as it will help resources injured by the spill recover quickly.

PROJECT DESCRIPTION

A. Resources and/or Associated Services

The entire restoration effort would be enhanced by the successful implementation of this project. By providing an environmentally acceptable method of waste oil disposal the continuing introduction of hydrocarbons into the marine environment would be reduced thus permitting natural recovery to continue as quickly as possible.

B. Objectives

To reduce the incidental introduction into the spill area ecosystem by providing a preferred method of disposal of waste oil products.

C. Methods

This project would create a waste oil recycling and/or disposal pilot program in a few communities that wish to participate. Depending on the success of the program this year, it will be proposed for expansion in future years. Communities could propose to use marine pollution control grants from the Trustee Council to purchase equipment for recycling and/or disposing of waste oil depending on what method(s) the community felt most appropriate to the local conditions. Volume of waste oil, distance from recycling centers, the need or opportunity for re-use of oil, and the costs (in terms of both money and mechanical complexity) of continuing operation would be among the criteria used to evaluate proposals from the communities.

Communities wishing to participate in this program would submit proposals. An evaluation committee would review the applications for technical and regulatory feasibility. Awards would be made and the communities would begin installation.

These facilities would be wholly owned by the local organization or government that applied for the funding. Maintenance and operation would be paid by the communities through user fees, assessments, or cost-recovery plans (e.g., reuse of waste oil for heating municipal facilities) depending on the wishes and resources of the communities. The facilities would be monitored, information collected, and a report prepared detailing the success or failure of the project.

D. Location

Communities within the spill affected area.

E. Technical Support

A small amount of computer support would be required in collecting the data reported by the grantees and storing it in a data base. The information would be utilized in preparing a report for the Trustees as to the relative success of the project.

F. Contracts

Six contracts (or grants) will be let for the best project proposals. A contract with an accounting firm to oversee expenditures and pay appropriate bills incurred by participating communities will be needed.

SCHEDULES

February 1994	Prepare proposal packets and scoring criteria
March 1994	Send out proposal packets to communities and advertise
April 1994	Receive submittals, convene proposal evaluation committee, review and rank proposals, notify recipients, negotiate grant/contract awards
May - June 1994	Communities proceed with equipment purchases and development
July - August 1994	Project manager visit communities
September 1, 1994	Receive first project reports from communities
December 1, 1994	Receive second operations report from communities

EXISTING AGENCY PROGRAM

None

ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS

The Trustee Council would provide grants to individual communities. Contract/grant stipulations would require that these communities comply with all applicable NEPA regulations.

PERFORMANCE MONITORING

On-site visits will be made by the Project Manager. Fiscal oversight will be contracted with an accounting firm. Participating communities will develop individual reports. Individual reports will be compiled into a formal report for submission to the Trustees.

FY94 BUDGET ($K)

	ADEC
Personnel	49.6
Travel	19.9
Contractual	142.9
Commodities	2.4
Equipment	0.0
Capital Outlay	0.0
Subtotal	214.8
General Administration	17.4
Project Total	232.2
NEPA Compliance	0.0

94422

DETAILED PROJECT DESCRIPTION
IS NOT APPLICABLE FOR THIS PROJECT

94423

DETAILED PROJECT DESCRIPTION
IS NOT APPLICABLE FOR THIS PROJECT

BRIEF PROJECT DESCRIPTION FOLLOWS

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Title: Oil Spill Public Information Center

Project Number: 94423

Lead Agency: ADF&G

Cooperating Agency: ADEC

Cost of Project, FY94: **Cost of Project, FY95:**

Project Starting Date: February 1994 **Duration:** To Be Determined

Geographic Area: Spill Area

Introduction:

The Oil Spill Public Information Center (OSPIC) was established by agencies of the federal government to be a repository for information and materials generated as a result of cleanup, damage assessment and restoration efforts following the Exxon Valdez oil spill. The OSPIC opened in September 1990 with a staff of professional librarians and library technicians employed by CACI, Inc., an information management firm.

After the settlement of the litigation between Exxon and the state and federal governments, the OSPIC was funded by the settlement money as part of the Administrative Director's budget. Restructuring by the Executive Director resulted in the transfer of staff and funding to the Alaska Departments of Fish and Game, and Environmental Conservation. The OSPIC is now funded as a project in the 1994 Work Plan.

The primary collection focus of the OSPIC is the Exxon Valdez oil spill and subsequent restoration activities, with a secondary focus on oil spills in the marine environment. The OSPIC collection includes information from numerous disciplines of the natural and social sciences, economics, and law, in a variety of formats, including books, technical reports, micro fiche, maps, audio and video tapes, slides, and computerized databases.

The OSPIC staff provides services which include research, preparation of bibliographies, and document delivery. During the past three years, the OSPIC staff has received over 5,900 visitors including visitors from 25 countries, responded to 7,500 on site/off site reference requests, processed 1,152 interlibrary loans, performed 1,102 online searches, and distributed 13,185 documents.

Project Description:

The Oil Spill Public Information Center (OSPIC) supports the Mission of the Trustee Council in its efforts to restore the injured environment and facilitates meaningful public participation in the restoration process as mandated by the settlement agreement between the state and federal governments and Exxon.

The OSPIC serves local, state, national, and international users, including but not limited to scientists, government agency personnel, the business community, students, educators, the legal profession, and other information providers.

A. Resources and/or Associated Services:

Through the information services it provides to all users, the OSPIC serves all restoration activities.

B. Objectives:

1) Maintain the Trustee Council Administrative Record.

2) Provide the Trustee Council and the Restoration Work Force with services including document distribution and specialized reference service.

3) Acquire new books, technical reports, maps, audio tapes, video tapes, journals, slides, and other materials pertaining to the Mission of the library to insure the OSPIC collection remains current and complete.

4) Organize the acquired materials so that users can access the collection.

5) Provide information and circulate materials to local, state, national, and international users.

C. Methods:

All OSPIC staff members respond to information requests made in person, by telephone, fax, mail, or interlibrary loan from around the world. The OSPIC also serves resident users, including the Executive Director, the Restoration Work Force, the Public Information Officer, and other agency personnel.

Materials acquired by the OSPIC staff are analyzed and described for entry into the OSPIC collection according to standard library practice. Materials are then made ready for the shelves with appropriate physical processing.

The OSPIC collection is cataloged in the online database of the Western Library Network (WLN), a consortium of about 540 libraries in the western part of the United States, Canada, Australia, Korea, and Japan. Librarians from any member library can access OSPIC materials. Circulating materials are available for check out to Anchorage area residents, and via interlibrary loan to users outside the Anchorage area.

To conduct research and identify new items for acquisition, the OSPIC staff employs technology, including Dialog database services, and WLN's CD-ROM products, LaserCat and PolarPac. As a publicly funded library, the OSPIC will participate via the Alaska State Library in the Internet, a global network of over 10,000 computer networks in 85 countries linking 15 million users.

The OSPIC staff coordinates the distribution of the Natural Resource Damage Assessment Studies to 19 state and regional libraries and catalogs these reports in the WLN database. The OSPIC staff takes an active role in the publication of the NRDA final reports.

The OSPIC is a repository for documents produced for and by the Trustee Council, including meeting transcripts, budgets, work plans, and public comments. The Record is maintained as a certified Administrative Record to track the decision making process of the Trustees and to address issues of accountability.

D. Location:

The OSPIC is housed on the first floor of the Simpson Building at 645 G Street, Anchorage, Alaska.

E. Technical Support:

The analyst programmer provides routine maintenance of the LAN computer network and assistance in establishing a fulltext online service for the public.

F. Contracts:

Current contracts with vendors for information services, periodical subscriptions and equipment maintenance will continue.

Schedules

The OSPIC as a project begins in February 1994.

Existing Agency Program

None.

Environmental Compliance/Permit/Coordination Status

N/A

Performance Monitoring

Quarterly and annual reports documenting usage, acquisitions, expenditures, and user information needs will be submitted by the designated deadline.

FY94 Budget ($K)

Personnel	
Travel	
Contractual	
Commodities	
Equipment	
Capital outlay	
Subtotal	
General Administration	
Project Total	
NEPA Compliance	$0.0

94424

DETAILED PROJECT DESCRIPTION
IS NOT APPLICABLE FOR THIS PROJECT

94425

DETAILED PROJECT DESCRIPTION
IS NOT APPLICABLE FOR THIS PROJECT

EXXON VALDEZ TRUSTEE COUNCIL
FY 94 DETAILED PROJECT DESCRIPTION

Project title:	Experimental Harlequin Duck Breeding Survey
Project ID number:	94427
Project type:	Research/Monitoring
Project leader(s):	Daniel H. Rosenberg, Thomas C. Rothe
Lead agency:	Alaska Department of Fish and Game
Cooperating agencies:	U. S. Fish and Wildlife Service
Cost of project/FY 94:	$21.0K
Cost of project/FY 95:	$145.5K
Cost of Project/FY 96 and beyond:	Unknown
Project Start-up/Completion Dates:	May 1, 1994 to November 1, 1994
Geographic area of project:	Western Prince William Sound
Project leader:	Daniel H. Rosenberg
Lead agency project manager:	Joseph Sullivan

B. INTRODUCTION

Oil spill studies of harlequin ducks in western Prince William Sound (PWS) 1989-93 indicate an initial mortality up to 1,000 birds (spill-wide), consistently low numbers of birds during the breeding season, a lack of breeding activity on suitable streams 1991-92, negligible production of broods through 1993, and an apparent decline in post-breeding molting birds in the region. Two main hypotheses have been followed to explain these findings: (1) ingested oil is continuing to cause either mortality and/or sublethal impairment of reproduction; and/or (2) initial mortality caused significant losses to the local western PWS breeding component and subsequent low production. To date, oil has been found in a few harlequins collected during 1989-90 and 1993, and they continue to feed in oiled areas year around. However, no conclusive evidence has been found of histological or physiological effects from oil.

Regardless of ultimate causes, collective results of EVOS studies indicate serious population-level concerns for harlequin ducks in western PWS. Prompt focus on specific population parameters is necessary to determine the status and recovery potential of harlequin ducks. Sea duck populations, in general, are composed of long-lived birds that have delayed sexual maturity, low annual production rates, and "boom and bust" years. Consequently, sea duck population dynamics are quite sensitive to adult survival rates, size of the breeding component, and variable breeding propensity (% of adults breeding annually). Data on sex and age composition are very useful in examining these aspects of a population. To date, EVOS projects have gathered abundance and distribution data only on total harlequin ducks, with little information on sex and age composition, or proportions of paired birds. The focus of these projects has been extensive survey coverage and a diverse array of other time-consuming objectives. Also, efficient techniques for the kind of intensive survey required have not been developed for sea ducks.

Currently, there are no sufficiently measured parameters of harlequin population dynamics with which to construct a population model for Prince William Sound. Development of a reliable breeding bird survey is a critical prerequisite to evaluating the remaining reproductive potential in the western Sound and acquiring data to fill in several important model elements. The experimental survey described below is intended to provide a new tool for establishing quantified restoration goals and designing an effective monitoring program for harlequin ducks in PWS.

C. PROJECT DESCRIPTION

1. Resources and/or Associated Services:

The subject resource of this project is the harlequin duck in Prince William Sound. Results of this work will have a direct bearing on assessing the status and outlook for this resource for guiding agency management programs and policies related to public uses, especially subsistence and recreational hunting.

2. Relation to Other Damage Assessment/Restoration Work:

More specific information on harlequin duck population structure in PWS is absolutely vital to: (1) estimate post-spill harlequin breeding birds remaining in western PWS, (2) assess potential rates of long-term recovery/increase for the spill region, (3) establish definitive, realistic restoration goals, and (4) monitor a meaningful population parameter for progress toward goals. Pursuit of these data will provide a more reliable basis for restoration planning and be consistent with an adaptive management approach that allows more efficient allocation of efforts and enrichment of knowledge over time (e.g. for a long-term monitoring program).

3. Objectives:

The objectives of this project are to: (1) conduct limited intensive boat surveys of harlequin ducks in selected shoreline segments (previously surveyed) of western PWS during May and June; (2) test several methods of classifying age and sex composition of harlequin ducks in the region; (3) compare reliability of classification methods and select a viable option; and (4) design a sampling regime to reliably estimate number of adults and/or pairs in the survey region and recommend it for EVOS monitoring plans.

4. Methods:

Shoreline survey segments will be selected in western PWS from areas surveyed during 1991-93 and where sufficient numbers of harlequin ducks are likely to occur. Seasonal sex and age classification criteria will be developed from literature accounts, examination of study skins, and experience of previous investigators in Canada and the U.S. Surveys will be conducted over 1-2 weeks during late May and early June by 2-3 observers from a slow-moving boat within 100 m of shore, ideally during periods and tide stages when harlequins will be most visible. Field classification methods will include visual assessments by multiple observers, photography, videography, and other prospective means of capturing sex and age data. No birds will be captured or collected. After field studies are complete, analysis will include quantification of class data from visual observations and other media, comparison and corroboration of data among methods, and statistical description of results.

5. Location:

The project will be conducted in the oil spill area of western Prince William Sound, generally between Perry Island and LaTouche Island, including mainland coast. Potentially affected communities include Chenega and Whittier.

6. Technical Support:

The only potential need for technical support is access to videography editing equipment available in Anchorage through the National Biological Survey.

7. Contracts:

No contracts will be necessary for this project.

D. SCHEDULES

This project is a short-term experimental survey. Preparation and field work will be conducted from May 1-June 15, 1994. Data analysis and report writing will occur through October 1994. A final report will be produced by November 1, 1994.

E. EXISTING AGENCY PROGRAM

There are no other agency or non-agency contributions to this project. Neither ADFG nor USFWS have plans for work on harlequin ducks in this region in 1994.

F. ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS

This project will comply with all applicable requirements of the National Environmental Policy Act and all applicable ordinances, regulations, and laws. No environmental analysis is required for this study, which qualifies for categorical exclusion.

G. PERFORMANCE MONITORING

This study will be conducted and managed by the Division of Wildlife Conservation, Waterfowl Program. Project operations will be conducted by permanent staff of the division and supervised according to professional standards. The Waterfowl Coordinator will be responsible for technical and administrative oversight, including project design approval, staff assignments, budget monitoring, and quality control of products. Operations and data management will be controlled through supervision, appropriate staff training, and compliance with applicable SOP's. The products of this study will be peer reviewed internally and through prescribed EVOS processes.

H. COORDINATION OF INTEGRATED RESEARCH EFFORT

There are no other projects directly related to the work planned in this project, although results of USFWS boat surveys for birds and mammals may provide useful information. However, those surveys are conducted outside the harlequin duck breeding season (March and July). Eventually, the techniques developed on this project should provide a partial basis for future sea duck monitoring efforts. Subsequent EVOS program development can incorporate sea duck population dynamics information with intertidal and nearshore ecosystem projects.

I. PUBLIC PROCESS

A comprehensive survey program for harlequin ducks in Prince William Sound was proposed as part of the FY 94 Work Plan and reviewed by the public and EVOS personnel. This project is a small experimental effort related to that proposal.

J. PERSONNEL QUALIFICATIONS

Daniel H. Rosenberg — Project Leader

Dan Rosenberg has worked as a waterfowl biologist for The Alaska Department of Fish and Game (ADFG) since 1985. From 1980—1983 Mr. Rosenberg worked as a waterfowl biologist for the U.S. Fish and Wildlife Service and from 1983—1984 as a Habitat Biologist for ADFG. Mr. Rosenberg served on the adjunct faculty of Anchorage Community College from 1984 - 1987 as an instructor for courses in Ecology and Animal Behavior, and Fish and Wildlife Management.

Mr. Rosenberg has conducted extensive waterfowl population monitoring and habitat assessment surveys on the Copper River delta, Stikine River delta, Kenai wetlands, upper Cook Inlet, Aleutian Islands, and Kodiak Island. As project leader, Mr. Rosenberg has assessed impacts to waterfowl and wildlife populations from hydroelectric development, urban expansion, habitat alterations, chemical pollutants, timber harvest, and surface mining.

Mr. Rosenberg has conducted studies to assess impacts from chemical pollutants on waterfowl populations in Alaska wetlands. Mr. Rosenberg designed, supervised, and conducted the first definitive study to assess the physiological effects from the ingestion of spent lead shot on mallards and pintails in Alaska. As the ADFG representative on the Biological Technical Assistance Group for the Eagle River Flats (ERF), Mr. Rosenberg has been responsible for overseeing the investigation into the identification, and remediation of white phosphorous, and restoration of the ERF, the site of one of the largest waterfowl die-offs in Alaska from chemical pollutants.

Mr. Rosenberg has been responsible for ecological assessment, design, construction, and post—project monitoring of the first large scale experimental waterfowl habitat enhancement projects in Alaska and coordinated ADFG review of fish and wildlife impact analysis and mitigation planning for the Susitna Hydroelectric Project.

Mr. Rosenberg received a Bachelor of Science degree in Wildlife Management from Humboldt State University, Arcata, CA in 1979. Mr. Rosenberg was ADFG Wildlife Biologist of the Year in 1991, and Alaska Outdoor Council Waterfowl Conservationist of the Year in 1993.

Thomas C. Rothe, Project Supervisor

Tom Rothe earned a Bachelor of Science degree in Population Dynamics from the University of Wisconsin (1973), including background in environmental impact analysis, environmental law and public policy, and natural resource economics. He received a Master of Science degree in Animal Ecology from Iowa State University (1977) after research work on wetland ecology and behavioral biology of prairie ducks.

Mr. Rothe conducted wetland and waterbird studies in relation to petroleum development on Alaska's North Slope 1976-83 for the U.S. Fish and Wildlife Service.

During 1980-83 he supervised the Office of Special Studies in a program of baseline, pre-development, and mitigation studies for petroleum, mining, and wetland impact activities in northern, southcentral and southeastern Alaska. This work included studies of sea duck food habits and potential contamination from oil in Port Valdez and from metals near the Quartz Hill molybdenum mine near Ketchikan. In these capacities, Mr. Rothe has had extensive experience with the petroleum industry and their consultants (TAPS, Prudhoe/Kuparuk, NPR-A, ANGTS), interagency coordination, management of major field studies, and public involvement processes on natural resource issues.

Since 1983, he has been Waterfowl Coordinator for the Alaska Department of Fish and Game, responsible for a wide variety of waterfowl and habitat management programs. He currently serves as the Alaska member of the Pacific Flyway Council's Study Committee and the Council's technical representative to the international Arctic Goose Joint Venture. Mr. Rothe has been involved with flywaywide and international population management issues for over 10 years and has accumulated broad knowledge of waterfowl biology and ecology.

K. BUDGET

	ADF&G	TOTAL
Personnel	11.4	11.4
Travel	1.8	1.8
Contractual	1.5	1.5
Commodities	2.8	2.8
Equipment	1.0	1.0
Capital Outlay	0.0	0.0
Subtotal	18.5	18.5
General Administration	1.8	1.8
Project Total	20.3	20.3

EXXON VALDEZ[illegible]TEE COUNCIL
1994 Federal Fiscal Year Project Budget
October 1, 1993 - September 30, 1994

Project Description: Experimental Harlequin Duck Breeding Survey - This project is an experimental survey of harlequin ducks in Western PWS during the breeding season. Several methods will be tested during boat surveys to record sex and age classification data. Classification techniques will be compared and a reliable method will be chosen for application to future monitoring of breeding population structure. Products will include a comprehensive breeding season survey design.

Budget Category:	1993 Project No. 93033 Authorized FFY 93	'93 Report/ '94 Interim* FFY 94	Remaining Cost** FFY 94	Total FFY 94	FFY 95	Comment
Personnel	$0.0	$0.0	$11.4	$11.4	$108.5	
Travel	$0.0	$0.0	$1.9	$1.9	$6.5	
Contractual	$0.0	$0.0	$1.5	$1.5	$10.0	
Commodities	$0.0	$0.0	$2.8	$2.8	$17.0	
Equipment	$0.0	$0.0	$1.0	$1.0	$3.5	
Capital Outlay	$0.0	$0.0	$0.0	$0.0	$0.0	
Subtotal	$0.0	$0.0	$18.6	$18.6	$145.5	
General Administration	$0.0	$0.0	$1.8	$1.8	$17.0	
Project Total	$0.0	$0.0	$20.4	$20.4	$162.5	
Full-time Equivalents (FTE)	1.6	0.0	0.2	0.2	2.0	

Dollar amounts are shown in thousands of dollars.

Budget Year Proposed Personnel: Position Description	Reprt/Intrm Months	Reprt/Intrm Cost	Remaining Months	Remaining Cost
Wildlife Biologist III			0.5	$3.0
Wildlife Biologist II			1.5	$8.4
Program Manager				
Personnel Total	0.0	$0.0	2.0	$11.4

NEPA Cost: $0.0

*Oct 1, 1993 - Jan 31, 1994

**Feb 1, 1994 - Sep 30, 1994

07/14/93

1994

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Project Number: 94427
Project Title: Experimental Harlequin Duck Breeding Survey
Agency: AK Dept. of Fish & Game

FORM 2A
PROJECT
DETAIL

EXXON VALDEZ TRUSTEE COUNCIL
1994 Federal Fiscal Year Project Budget
October 1, 1993 - September 30, 1994

Travel:	Reprt/Intrm	Remaining
Two round trips Portage/Whittier @ $192/trip		$0.4
Two round trips Portage/Whittier @ $126/trip		$0.3
Four round trips Portage/Whittier @ $16/trip		$0.1
Per diem for Whittier trips 10 days @ $110/day		$1.1
Travel Total	$0.0	$1.9
Contractual:		
Air charter - 5.5 hours in a Beaver @ $275/hour		$1.5
Contractual Total	$0.0	$1.5

Project Number: 94427
Project Title: Experimental Harlequin Duck Breeding Survey
Agency: AK Dept. of Fish & Game

FORM 2B
PROJECT
DETAIL

EXXON VALDEZ [redacted]TEE COUNCIL
1994 Federal Fiscal Year Project Budget
October 1, 1993 - September 30, 1994

	Reprt/Intrm	Remaining
Commodities:		
Food and supplies for field camps		$0.6
Fuel for boat (1 boat x 60 gallons/day x $1.50/gallon x 15days)		$1.4
Film/video supplies		$0.5
Parts for boat repairs		$0.3
Commodities Total	$0.0	$2.8
Equipment:		
Photo/video accessories		$1.0
Equipment Total	$0.0	$1.0

07/14/93

1994

Printed: 4/7/94 5:04 PM

Project Number: 94427
Project Title: Experimental Harlequin Duck Breeding Survey
Agency: AK Dept. of Fish & Game

FORM 2B
PROJECT
DETAIL

B-
Please file w/
project #94427
Harlequin Duck Survey.

FAX C

TO: Bob Spies/Andi

FROM: Eric Myers

DATE: 4/19/94

SUBJ: Project #9442

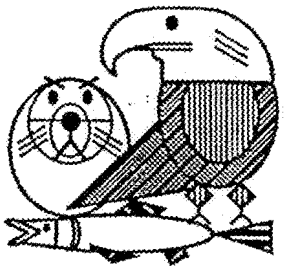
NUMBE

Note: I already faxed the DPD to Anne/Spies. + confirmed that it got through in good shape. No need to send hard copy accordingly.

Please review this
the project fundi
development of fie
for future application, you may wish to consider whether the project is "without sophisticated or complex scientific components [and therefore does] not need" outside peer review (Spies/Gunther memo to McCammon 3/16)

Thanks, Eric

Exxon Valdez Oil Spill Trustee Council
Restoration Office
645 G Street, Suite 401, Anchorage, AK 99501-3451
Phone: (907) 278-8012 Fax: (907) 276-7178



MEMORANDUM

TO: Bob Spies, Chief Scientist
Attn: Andy Gunther

FROM: Eric Myers, Project Coordinator

DATE: 4/18/94

SUBJ: DPD for Project #94427/Experimental Harlequin Duck Breeding Survey

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Please find enclosed a copy of the Detailed Project Description for Project #94427/Experimental Harlequin Duck Breeding Survey (undated). As you know, the Trustee Council approved funding for this recently developed project at their most recent meeting on April 11, 1994.

As indicated by the DPD, the project calls for a short-term experimental survey effort designed to develop field classification methods as a means of capturing sex and age data needed to provide more information on harlequin duck population structure. To date, as indicated by the DPD, EVOS related harlequin projects have gathered abundance and distribution data only on total harlequin ducks with little information on sex and age composition or proportion of paired birds.

Please expedite the review of this project. The DPD calls for preparation and field work between May 1 and June 15, with 1-2 weeks in the field during late May/early June.

If you have questions concerning this DPD, please let me know.

enclosure

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94428

EXXON VALDEZ TRUSTEE COUNCIL
FY 94 PROJECT DESCRIPTION

A. COVER PAGE

Title: Subsistence Restoration Planning and Implementation
Project Identification Number: 94428
Lead Agencies: Alaska Department of Fish and Game, United States Department of the Interior, U.S. Forest Service
Cooperating Agencies: Alaska Department of Community and Regional Affairs; Alaska Department of Law
Cost of Project: $99,084
Project Startup Date: April 15, 1994
Duration: April 15, 1994 - September 30, 1994
Geographic Area: Prince William Sound, lower Kenai Peninsula, Kodiak Island, and Alaska Peninsula

Project leader: James A. Fall

Program Manager: Joseph R. Sullivan

B. INTRODUCTION

Subsistence uses of fish and wildlife are a vital service that was impaired as a result of the Exxon Valdez oil spill. After the spill, harvest levels declined, sharing of resources was reduced, and the transmission of skills and knowledge about natural resources was disrupted. While harvest levels and participation in subsistence activities have rebounded somewhat since the first two post-spill years, effects of the spill remain. These include concerns about the long term health effects of using resources from the spill area, a loss of confidence in individuals' abilities to judge if resources are safe to eat, scarcity of certain injured subsistence resources (natural resources such as harbor seals, marine invertebrates, and waterfowl) in traditional harvest areas, increased costs associated with subsistence harvests, and reduced opportunities for young people to learn the subsistence way of life.

An overview of natural resource damage assessment (NRDA) studies indicated several continuing impacts to subsistence. These included: 1) uncertainty concerning the availability and wholesomeness of key subsistence resources; 2) reduced availability of many subsistence species; and 3) reduced efficiency in subsistence harvesting activities because resources of smaller individual size have been harvested in reduced amounts during each harvest effort. It is likely that the persistence of oil in the environment, such as in mussel beds, will continue to harm resources and retard biological recovery. These impacts can be linked to non-natural resource aspects of subsistence use, including nutrition, sharing, cultural knowledge, and social organization.

The purpose of this project is to design a coordinated approach to subsistence resource restoration and implement a planning process to develop subsistence restoration project proposals for the Trustee Council Work Plan for FY 95. A further goal is to insure the participation of subsistence users in these and other FY 95 planning efforts. Such projects could propose to directly restore resources used for subsistence, provide alternative natural resources, or restore access or people's use of the resource. Guidelines for project content will be developed, project ideas will be solicited and prioritized through a public process, project proposals will be evaluated, and a set of project proposals will be presented to the Trustee Council for funding consideration.

Project ideas developed through this planning process which do not become part of the FY 95 Work Plan may be eligible for funding through grants from a $5 million appropriation of Exxon Valdez criminal settlement funds by the Alaska Legislature. The legislature authorized the Department of Community and Regional Affairs to award grants to unincorporated rural communities in the oil spill area in order to restore, replace, or enhance subsistence resources or services damaged or lost as a result of the spill (Section 11, Chapter 79, SLA 1993). The legislation requires that selection of grant recipients shall be made after consultation with the state members of the Trustee Council.

In addressing lost or reduced services provided by injured resources, the development of this planning program is consistent with an ecosystem approach towards restoration endorsed by the Trustee Council.

C. PROJECT DESCRIPTION

1. Resources and/or Associated Services. The purpose of the project is to collaboratively develop a coordinated approach to restoration of subsistence resources and to develop and evaluate proposals to restore or enhance injured subsistence resources and lost or diminished subsistence uses.

2. Relation to Other Damage Assessment/Restoration work. The FY 94 Restoration Plan includes two subsistence restoration projects: 94244 (Harbor Seal and Sea Otter Co-op Subsistence Harvest Assistance) and 94279 (Subsistence Food Safety Testing). Aspects of these projects may be continued as part of projects developed during the cooperative planning effort. Projects more appropriately supported through grants from the $5 million appropriation from the criminal settlement money may also be identified.

3. Objectives. The project has three primary objectives. The first objective is to design a comprehensive approach to subsistence restoration. The second objective is to meet with residents of the subsistence communities in the spill area to identify community needs and priorities related to injured subsistence resources and services. The third is to work with communities to develop proposals to restore reduced or lost subsistence resources and services.

4. Methods. Guidelines for appropriate topics for projects will be developed as part of a coordinated approach to subsistence restoration by the Alaska Department of Fish and Game (Division of Subsistence), the Alaska Department of Community and Regional Affairs (DCRA) (Division of Municipal and Regional Assistance), the U.S. Department of the Interior, and the U.S. Forest Service (the latter two agencies representing the federal Trustee Council members), with assistance from the Alaska Department of Law, Trustee Council staff, and representatives of spill-area communities. An outreach program in subsistence communities will be conducted to solicit ideas and priorities for restoration of subsistence resources and lost or reduced subsistence uses. A local community facilitator will be hired as a nonpermanent employee within the Division of Subsistence to assist with the planning and implementation of community meetings and workshops. Following the meetings, interested parties may develop projects as proposals for funding, for which project staff will provide assistance. After evaluation of the proposals, recommendations will be presented to the Trustee Council for review.

5. Location. Prince William Sound, Cook Inlet, Kodiak Island Borough, and the Alaska Peninsula within the spill area

6. Technical Support. This project will not need technical support as described in the proposal guidelines.

7. Contracts. Development of the program itself will not require contracts.

D. SCHEDULES

April 15 - May 15, 1994: Develop draft guidelines
May 9 - May 15. Possible workshop in Anchorage with community or regional representatives
May and June 1994: Community meetings to develop project priorities and proposals.

Tentative meeting schedule

May 5 - May 11. Alaska Peninsula communities; meetings in Perryville and Chignik
May 16 - May 20. Meetings in Tatitlek, Cordova, Chenega Bay, Valdez
May 23 - May 30. Meetings in Nanwalek, Port Graham, Seldovia, Seward
June 1 - 2. Workshop in Kodiak; community representatives from Akhiok, Karluk, Kodiak, Larsen Bay, Old Harbor, Ouzinkie, Port Lions

July - early August 1994: assist communities to develop proposals; proposal evaluation
August 15: Publication of project proposals in Draft FY 95 Work plan
September 1994: Second round of community meetings to develop project ideas for next funding cycle
October 1994: Trustee Council Meeting.
November 1994 - March 1995: Monitor projects and evaluate proposals; continue development of proposals for future work plans (if second year of funding provided).

E. EXISTING AGENCY PROGRAM

The ADF&G Division of Subsistence maintains an ongoing program of data collection and report preparation about the role of subsistence activities in Alaska, including the spill area communities. The division is currently involved in a joint project with the U.S. Minerals Management Service, which, among other things, is investigating social effects of the spill. The division is also actively engaged in research on subsistence harbor seal and sea lion harvests in coastal communities of southcentral and southwest Alaska, supported by the National Marine Fisheries Service. In addition, the division is the lead agency on two FY 94 oil spill restoration projects: Project 94279, Subsistence Foods Safety Testing; and Project 94244, Harbor Seal and Sea Otter Co-op Subsistence Harvest Assistance. The Division of Community and Regional Assistance (within DCRA) provides technical assistance services, including grants administration, to communities and has administered an emergency oil spill impact program in the spill area. The U.S. Department of the Interior and the U.S. Forest Service are responsible for management of subsistence activities on federal lands and are member agencies of the Trustee Council.

F. ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS.

This project is categorically excluded under NEPA guidelines.

G. PERFORMANCE MONITORING

Performance monitoring will be conducted jointly by staff of the Division of Subsistence, the Division of Municipal and Regional Assistance (MARAD), the U.S. Department of the Interior (USDOI) and the U.S. Forest Service (USFS). Generally, the Division of Subsistence will have primary responsibility for monitoring the technical adequacy of projects, with assistance as necessary form USFS and USDOI, while MARAD staff will monitor the administrative and management adequacy of projects supported by grants from the state's appropriation of criminal settlement funds. The Division of Subsistence and MARAD will develop a general agreement based on the preceding and, for particularly complex projects, may develop specific agreements relating to the performance monitoring of that particular project.

H. COORDINATION OF INTEGRATED RESEARCH EFFORT

As a planning project, a goal of this project will be to coordinate the subsistence restoration program with other research efforts.

I. PUBLIC PROCESS

Community meetings and workshops will be held to solicit project ideas and priorities. Information about the projects will be communicated in the Subsistence Restoration Newsletter produced by the Division of Subsistence. Additionally, state, federal, and private land managers, Native regional non-profit corporations, and federal subsistence regional councils will be kept informed of the process and their ideas and input will be sought.

J. PERSONNEL QUALIFICATIONS

James Fall. Dr. Fall is the regional program manager for the Division of Subsistence, ADF&G, for southcentral and southwest Alaska. Since 1989, he has supervised the division's oil spill response and research program.

Rita Miraglia. Ms Miraglia has served as the oil spill coordinator for the Division of Subsistence since 1990. As such, she has organized and participated in the subsistence resource collection and testing program of 1990, 1991, and 1993. She has also been the lead communicator of study findings to communities through organizing community meetings and writing newsletters.

Jody Seitz. Ms Seitz has worked as a subsistence resource specialist with the Division of Subsistence since 1989, with responsibility for Prince William Sound communities since 1991.

Craig Mishler. Since 1989, Dr. Mishler has been the subsistence resource specialist with the Division of Subsistence with responsibility for the Kodiak Island Borough and the division's multi-regional harbor seal and sea lion project.

Lisa Scarbrough. Ms Scarbrough is the subsistence resource specialist with the Division of Subsistence with responsibility for the Alaska Peninsula communities (among others), a position she has held since 1989.

Pat Poland. Mr. Poland is Deputy Director, Division of Community and Regional Assistance, DCRA. He has been responsible for day-to-day management of the division's Technical Assistance and Program Delivery services for a number of years. This experience includes oversight of an emergency oil spill impact grant program following the Exxon Valdez spill.

K. BUDGET

Personnel: $63,925

Subsistence Resource Specialist II. Project Coordinator. 5.5 months ($25,025)
Subsistence Resource Specialist II. Prince William Sound, 1.5 months ($7,050)
Subsistence Resource Specialist II. Alaska Peninsula/Kodiak, 1.5 months ($7,050)
Regional Program Manager, 1 month ($7,200)
Fish and Wildlife Technician III, 2 months (local community facilitator) ($5,000)
U.S. Department of the Interior Representative (Don Callaway), 1 month ($6,300)
U.S. Forest Service Representative (Steve Zemke), 1 month ($6,300)

Travel		$24,000
Community Meetings and Coordinator Travel	$22,000	
Per diem, USFS	1,000	
Per diem, USDOI	1,000	
Printing, etc.		$ 1,000
Supplies		$ 500
SUB TOTAL		$89,425
General Administration		$ 9,659
GRAND TOTAL		$99,084

John Gliva. Mr. Gliva is a Planner IV with the MARAD division and has worked extensively at providing technical assistance services to Prince William Sound communities. Additionally, he developed regulations for administration of the Emergency Oil Spill Impact Program and generally administered the application and award process.

Don Callaway. Dr. Callaway is a subsistence specialist with the National Park Service (USDOI) Alaska regional office. Prior to this appointment, he helped design studies of the sociocultural effects of the oil spill as a member of the staff of the socioeconomic studies unit of the U.S. Minerals Management Service.

Steve Zemke. Mr. Zemke is the subsistence coordinator for the Chugach National Forest (USFS). He has contributed to the environmental impact statement (EIS) for the oil spill restoration program.

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NO DETAILED PROJECT DESCRIPTION REQUIRED --
PROJECT IS A CONTINUATION OF
PREVIOUSLY APPROVED WORK

BRIEF PROJECT DESCRIPTION FOLLOWS

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Title: Genetic Stock Identification of Kenai River Sockeye Salmon

Project Number: 94504

Lead Agency: ADF&G

Cooperating Agency: None

Cost of Project, FY94: $262.2K **Cost of Project, FY95:** $0.0

Project Startup Date: September 1993 **Duration:** Closeout

Geographic Area: Kenai Peninsula Region

INTRODUCTION

This project is the closeout of an ongoing project to identify Kenai River sockeye salmon stocks.

PROJECT DESCRIPTION

A. Resources and/or Associated Services

The information gathered during this project will aid in management of Kenai River sockeye salmon to restore and/or provide a replacement for salmon stocks injured by the *Exxon Valdez* oil spill. The current funding request is for closeout costs and preparation of the final project report.

B. Objectives

This project identifies Kenai River, Kasilof River, and Susitna River salmon stocks in order to protect Kenai stocks and allow commercial harvest of other healthy stocks. As a closeout project, the funding includes laboratory analysis of samples collected in summer 1993. A final report will be prepared for the peer-review process and presentation to the Trustee Council.

C. Methods

Laboratory analysis of allozymes identifying various stocks will be done by the ADF&G Genetics laboratory. The analysis will involve thousands of samples collected in summer 1993 during Project #93012.

D. Location

Kenai Peninsula.

E. Technical Support

Computer, GIS, and statistical support will be provided by project personnel from the Alaska Department of Fish and Game. Lab work will be performed at the ADF&G Genetics laboratory.

F. Contracts

Maintenance contracts for laboratory equipment. Phone, postage, and other office maintenance contracts.

SCHEDULES

Table 1. Schedule of activities from September 1993 through April 1994:

October 1993-April 1994	Final data analysis
May-June 1994	Prepare final report

EXISTING AGENCY PROGRAM

None.

ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS

This project received a categorical exclusion under NEPA compliance regulations in 1993.

FY94 BUDGET ($K)

	ADF&G
Personnel	186.5
Travel	12.0
Contractual	10.0
Commodities	25.0
Equipment	0.0
Capital Outlay	0.0
Subtotal	233.5
General Administration	28.7
Project Total	262.2
NEPA Compliance	0.0

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NO DETAILED PROJECT DESCRIPTION REQUIRED --
PROJECT IS A CONTINUATION OF
PREVIOUSLY APPROVED WORK

BRIEF PROJECT DESCRIPTION FOLLOWS

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Title: Habitat Protection Information for Anadromous Streams and Marbled Murrelets

Project Number: 94505

Lead Agency: USDA-FS

Cooperating Agency: ADF&G, USDI-F&WS

Cost of Project, FY94: $406.0K **Cost of Project, FY95** $0.0K

Project Startup Date: October 1993 **Duration:** Closeout project

Geographic Area: Prince William Sound and the Gulf of Alaska

INTRODUCTION

A. Resources and/or Associated Services

This project is the closeout of an ongoing project, 93051, to collect habitat information to restore resources and services injured by the *Exxon Valdez* oil spill. Information on Marbled Murrelet nesting habitat, and anadromous streams was collected during the 1993 field season. The current funding request is for closeout costs and preparation of the final project reports.

B. Objectives

The primary objectives of this project are as follows:

1. survey anadromous fish distribution and document the total number and extent of anadromous fish streams on lands being considered for habitat protection

2. determine habitat features that are reliable indicators of high density murrelet nesting areas in the spill-affected area

3. determine the feasibility of using radio telemetry to determine nesting habitat of murrelets in the spill-affected area

4. develop channel typing procedures that will allow comparative evaluation of stream habitat on private and public lands.

C. Methods

Data analysis and mapping will be performed. Final reports will be prepared.

D. Location

Prince William Sound and the Gulf of Alaska

E. Technical Support

Computer, GIS, and statistical support will be provided by agency personnel. Some training of project personnel on GIS will be required.

F. Contracts

Maintenance contracts for field and office equipment will be needed.

SCHEDULES

October 1993 to March 1994	Final data analysis
March 1994 to April 1994	Produce final report

EXISTING AGENCY PROGRAM

None.

ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS

This project was categorically exempt from documentation in an EA or EIS under Forest Service NEPA implementing regulations in 1993.

FY94 BUDGET ($K)

	ADF&G	USFS	USFWS	TOTAL
Personnel	112.7	150.7	63.0	326.4
Travel	0.0	3.3	0.0	3.3
Contractual	5.5	7.9	0.2	13.6
Commodities	1.2	2.0	1.0	4.2
Equipment	0.8	7.0	0.8	8.6
Capital Outlay	0.0	0.0	0.0	0.0
Subtotal	120.2	170.9	65.0	356.1
General Administration	17.3	23.2	9.5	49.9
Project Total	137.5	194.1	74.5	406.0
NEPA Compliance	0.0			

94506

NO DETAILED PROJECT DESCRIPTION REQUIRED --
PROJECT IS A CONTINUATION OF
PREVIOUSLY APPROVED WORK

BRIEF PROJECT DESCRIPTION FOLLOWS

EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

Title: Pigeon Guillemot Recovery

Project Number: 94506

Lead Agency: DOI-USFWS

Cooperating Agency: None

Cost of Project, FY94: $13.9K

Cost of Project, FY95: $0.0

Project Startup Date: September 1993

Duration: Closeout

Geographic Area: Prince William Sound

INTRODUCTION

This project is the closeout of an ongoing project to identify breeding areas of pigeon guillemots in Prince William Sound which may need protection or other restoration action.

PROJECT DESCRIPTION

1. Resources and/or Associated Services

The information gathered during this project will aid in management of pigeon guillemot populations injured by the *Exxon Valdez* oil spill. The current funding request is for closeout costs and preparation of the final project report.

2. Objectives

A final report will be prepared for the peer-review process and presentation to the Trustee Council.

3. Methods

The report will present information collected in summer 1993 during Project #93034.

4. Location

Prince William Sound (primarily the western portion).

Technical Support

Computer and statistical support will be provided by project personnel from the Department of the Interior, Fish and Wildlife Service.

6. Contracts

None.

SCHEDULES

Table 1. Schedule of activities from September 1993 through April 1994:

Oct. 1993-Mar. 1994	Final data analysis
Mar-Apr. 1994	Prepare final report

EXISTING AGENCY PROGRAM

None.

ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS

This project received a categorical exclusion under NEPA compliance regulations in 1993.

FY94 BUDGET ($K)

	USFWS
Personnel	9.7
Travel	2.7
Contractual	0.0
Commodities	0.0
Equipment	0.0
Capital Outlay	0.0
Subtotal	12.4
General Administration	1.5
Project Total	13.9
NEPA Compliance	0.0

94507

NO DETAILED PROJECT DESCRIPTION REQUIRED --
PROJECT IS A CONTINUATION OF
PREVIOUSLY APPROVED WORK