19.2.4

10/17/94.rev

Revised Brief Project Descriptions

The following Brief Project Descriptions (BPDs have been revised since publication of the *Draft Fiscal Year 1995 Work Plan.*

95052	Community Interaction/Use of Traditional Knowledge	
95080	Fleming Spit Recreation Area	
95089	Information Management System	
95093	PWSAC Project Overview/Wild Stock Restoration	
95093A	Restoration of Salmon in 3 Oil Damaged Streams	
95093B	Diversion of Fishing Effort from Oil Damaged Streams	
95093C	Restoration of 3 Salmon Stocks Important to Subsistence	
95115	Sound Waste Management Plan	
95124A	Tatitlek Mariculture Development Project	
95127	Tatitlek Coho Salmon Release Program	
95129	Tatitlek Fish and Game Storage and Processing Center	
95131	Nanwalek/Port Graham/Tatitlek Clam Restoration Project	
99133	English Bay River Sockeye Salmon Subsistence Project	
95134	Chenega Bay Mariculture Development Project	
95138	Elders/Youth Conference on Subsistence and the Oil Spill	
95163A-I	Seabird/Forage Fish — Overview	
95163A	Forage Fish Assessment	(formerly Project 95163)
95163B	Forage Fish Assessment/Birds	(formerly Project 95163)
95163C	Forage Fish Diets	(formerly Project 95163)
95163D	Puffins as Samplers	(formerly Project 95019)
95163E	Kittiwakes as Indicators	(formerly Project 95033)
95163F	Pigeon Guillemot Recovery	(formerly Project 95173)
95163G	Seabird Energetics	(formerly Project BAA-118)
95163H	Energy Composition of Fish	(formerly Project BAA-120)
95163I	Forage Fish-Seabird Program Management and Integration	
95279	Subsistence Food Safety Testing	
95320C	Otolith Marking of Hatchery Reared Pink Salmon in PWS	

NOTE: In Addition to those projects noted above, two additional project BPDs are currently still under revision:

1) 95058/Restoration Assistance to Private Landowners; and
2) 95XXX/Killer Whale Monitoring - Research (this project will combine elements of the four previously submitted killer whale projects).

Community Interaction/Traditional Knowledge REVISED 10/17/94

Project Number:	95052
Restoration Category:	General Restoration (new)
Proposed By:	Molly McCammon, Director of Operations *Exxon Valdez* Oil Spill Trustee Council
Lead Trustee Agency:	ADFG
Cooperating Agency:	ADNR
Cost FY 95:	$150,200
Cost FY 96:	$150,200
Total Cost:	Unknown
Duration:	Multiple years
Geographic Area:	Oil spill area
Injured Resource/Service:	Multiple resources

INTRODUCTION

The *Exxon Valdez* oil spill caused severe disruption of the lives of many people living in the spill impact area. The spill also caused residents of the area to be concerned about the safety of their wild food sources, and the integrity of the surrounding natural environment. While scientific studies aimed at restoring the resources and services damaged by the oil spill have occurred throughout the spill area, most of the researchers work for agencies or institutions based in Anchorage, Fairbanks, or outside Alaska. Residents have complained of a lack of involvement by spill area communities in the restoration efforts, and incomplete communication to spill area inhabitants of study proposals and results. At the same time, researchers have recognized that local residents have traditional knowledge that could help them answer questions they have not been able to answer through conventional scientific means. People living in the spill area have detailed knowledge about the condition of resources, which can significantly add to data collected as part of scientific studies, and possibly even enhance the success of restoration efforts. Local people have expressed a desire to be involved in all aspects

of restoration projects, and a willingness to work with researchers. This project intends to increase the involvement of spill area communities in the restoration efforts of the Trustee

Council, and to improve the communication of findings and results of restoration efforts to spill area inhabitants.

NEED FOR THE PROJECT

At present, there is no formal program in place to effectively facilitate communication between the Trustee Council, researchers working on oil spill restoration projects, and residents of communities impacted by the oil spill. This project will initiate a program to encourage and facilitate such communication. The goal is to make optimal use of the complementary nature of scientific data and traditional knowledge.

PROJECT DESIGN

A. Objective

The objective of the project will be to increase the involvement of spill area communities in the restoration efforts of the Trustee Council, and to improve the communication of findings and results of restoration efforts to spill area inhabitants.

B. Methods

The project will be coordinated by the Trustee Council's Director of Operations, and implemented by the Alaska Department of Fish and Game's Division of Subsistence. Subsistence Division representatives will work closely with other Trustee Council agencies, scientists, and community members in implementing the project. In particular, the Alaska Department of Natural Resources will assist with the assembly of materials dealing with cultural resources, and will participate in community meetings, evaluation of the success of the pilot portion of the project, and writing of the final report.

The objective will be achieved using the following methods:

1. Publishing a newsletter in conjunction with the Trustee Council newsletter. Currently, the Subsistence Division publishes a quarterly newsletter which focuses primarily on food safety issues and is sent to all subsistence users in the spill area (funding for this newsletter will cease with the close-out of Project 95279). The Trustee Council also publishes a newsletter approximately six times a year to update interested members of the public about actions and plans of the Trustee Council. The newsletter proposed under this project will be a collaboration of these two efforts. The focus of the newsletter will include discussion of ongoing research and restoration efforts, and study findings and results.

2. Identifying those projects funded by the Trustee Council for which a community outreach component would be appropriate, and working with the principal investigators of those projects to design and implement community outreach components. The goal of community outreach will be to develop an informal partnership between the people of the oil spill region and scientific researchers. Outreach will include communication of traditional knowledge and local interests, as well as communication of research proposals and study results. Community meetings, as well as informal networking facilitated by the Subsistence Division (i.e., telephone calls, letters, household visits), will take place.

3. In each of three pilot communities (Tatitlek, Chenega Bay, and Port Graham), contracting with a local person to facilitate the community outreach described in (2) above. The local facilitators will serve as liaisons between the community and researchers, and between the community and Trustee Council/Agency staff. In addition, the local facilitators will arrange local support and equipment for researchers working in their communities.

C. Schedule

November 1994	Hire local facilitators in pilot communities
Nov/Dec 1994	Develop contract guidelines, evaluate bids, award contract for design/ moderation of elders/youth conference (Project 95138)
December 1994	Complete identification of projects in need of a public outreach component; being working with PIs to design and implement
January 1995	Informational newsletter issued
March 1995	Informational newsletter issued
April 1995	Have outreach components in place in time for start of field season
June 1995	Informational newsletter issued
September 1995	Informational newsletter issued

D. Technical Support

None required.

E. Location

This project will be conducted throughout the spill area. The communities proposed for the pilot component of the project are Tatitlek, Chenega Bay, and Port Graham.

PROJECT IMPLEMENTATION

The project will be coordinated by the Trustee Council's Director of Operations, and implemented by the Alaska Department of Fish and Game's Division of Subsistence. Subsistence Division representatives will work closely with other Trustee Council agencies, scientists, and community members in implementing the project.

COORDINATION OF INTEGRATED RESEARCH EFFORT

The project will provide for greater involvement of inhabitants of the oil spill area in the restoration and research effort of the Trustee Council.

FY 95 BUDGET ($K)

Personnel	51.7
Travel	14.0
Contractual	72.0
Commodities	0.5
Equipment	0.0
Subtotal	138.2
Gen. Admin.	12.0
Total	150.2

Fleming Spit Recreation Area

Project Number:	95080 (Revised, 9/15/94)
Restoration Category:	General Restoration
Proposed By:	The Cordova Sporting Club
Lead Trustee Agency:	Alaska Department of Natural Resources
Cooperating Agencies:	Alaska Department of Fish and Game
Cost FY 95:	$815,800
Cost FY 96:	$0
Total Cost:	$815,800
Duration:	2-3 years
Geographic Area:	Prince William Sound
Injured Resource/Service:	Recreation and pink salmon

INTRODUCTION

Fleming Spit is located on Orca Inlet within the city limits of Cordova. It is at the mouth of Fleming Creek, which has small native runs of coho, pink, and chum salmon. Fleming Spit is also the site of a strong terminal coho sport fishery and a fledgling king salmon fishery. The area is accessible when weather prohibits boating.

The proposed project would replace sport fishing opportunities lost due to the oil spill; improve the habitat of native fish stocks in Fleming Creek; and repair damage to Fleming Spit resulting from illegal camping by cleanup workers. It proposes the following improvements:

- acquisition of a parcel of land at the mouth of Fleming Creek;
- enlargement and improvement of smolt release ponds;
- the construction of permanent net pens;
- the construction of a parking area, a fishing boardwalk, public restrooms, and two fish-cleaning stations; and
- general cleanup of the area, including the removal of a derelict barge.

Proposed improvements in the Fleming Spit Recreation Area were supported by resolution of the Cordova City Council in July 1991. It also has strong support from recreation users in Prince William Sound. Initially proposed as part of the Prince William Sound Recreation

Project (Project #93065 and #94217), it was evaluated at a public participation workshop in November 1993 and ranked eighth among 30 projects.

NEED FOR THE PROJECT

The proposed project would replace sport fishing opportunities lost due to the oil spill and improve the and habitat of native fish stocks in Fleming Creek. It would also repair damage to Fleming Spit from illegal camping by cleanup workers.

There was a significant decline in sport fishing in the oil spill area following the spill. The loss to sport anglers in 1989 is estimated to be $31 million. In 1992, cutthroat trout sport fishing in western Prince William Sound was closed due to reduced growth and survival. Many residents of Cordova are hesitant and concerned about sport fishing in oiled areas

By acquiring a parcel of private land at the mouth of Fleming Creek and managing them primarily for conservation, the proposed project would help protect the riparian habitat that supports native stocks, including pink salmon. Pink salmon were injured by the spill and have not yet recovered. The parcel is also needed for facilities such as off-street parking, bathrooms, and fish cleaning stations. However, the placement and design of these facilities will be sensitive to the habitat requirements of the native fish stocks in Fleming Creek. (The parcel is zoned Conservation in the Cordova Coastal Management Plan.)

Two of the proposed improvements — a dredge and fill project and the construction of permanent net pens — would directly benefit the terminal fisheries. Existing smolt release ponds are shallow, exposing smolts to bird predation and causing net pens to ground. Net pens should be kept floating to maintain proper circulation. The dredge and fill project would deepen smolt release ponds and allow net pens to float at all tide stages, thereby decreasing mortality among young salmon. The existing fishery operates with two mobile net pens temporarily on loan from the Prince William Sound Aquaculture Corporation. Continuation of the terminal fisheries requires replacement of the mobile net pens with permanent net pens.

The four facilities proposed in this project would provide for safe access and improve sanitation. At present, cars park on the road; people access the fishing area via a steep, rocky slope; and there are no visitor facilities. Off-street parking and a 1,000-foot fishing boardwalk parallel to the road would make access to the fishing area safer. Public restrooms and two fish-cleaning stations would improve sanitation.

The Fleming Spit camp area was injured in 1989 and 1990 by cleanup workers responding to the *Exxon Valdez* oil spill. Sanitation problems and resource degradation resulted from illegal camping (*Draft Restoration Plan*, Nov. 1993, p. B-32.). The project proposes to clean up the trash in the area, especially that left behind by oil spill cleanup workers, and to remove a derelict barge.

PROJECT DESIGN

A. Objectives

1. Replacement of sport fishing opportunities lost because of the oil spill.

2. Protection of riparian habitat along Fleming Creek.

3. Repair of damage to Fleming Spit from illegal camping by cleanup workers.

B. Methods

1. Acquire parcel of land (USS 252) at the mouth of Fleming Creek.

2. Dredge and fill the existing smolt ponds.

3. Construct permanent net pens.

4. Construct off-street parking, a fishing boardwalk, toilet facilities, and two fish cleaning stations.

5. Clean up the area and remove a derelict barge.

C. Schedule

To be developed.

D. Technical Support

None.

E. Location

Fleming Spit is located within the city limits of Cordova. It is adjacent to the ferry dock and 1.5 miles from town.

PROJECT IMPLEMENTATION

The proposed project would be implemented through a contract with the City of Cordova. The city would negotiate acquisition land interests; hold title to the acquired land; obtain required permits; comply with the requirements of the National Environmental Policy Act (NEPA); and construct and maintain proposed facilities.

COORDINATION OF INTEGRATED RESEARCH EFFORT

Not applicable.

FY 95 BUDGET ($K)

Personnel	0.0
Travel	0.0
Contractual	790.0*
Commodities	0.0
Equipment	0.0
Subtotal	790.0
Gen. Admin.	25.8
Total	815.8

* Proposed as a grant to the City of Cordova for the following activities

Acquire parcel	150.0
Dredge and fill operations	150.0
Permanent net pens	20.0
Flood plain management	50.0
Surveying	30.0
Off street parking	30.0
Fishing boardwalk	300.0
Toilet facilities	40.0
Fish cleaning stations	10.0
Barge removal	10.0

Information Management System - (Revised - 10/17/94)

Project Number:	95089
Restoration Category:	Administration, Public Information and Science Management
Proposed By:	Molly McCammon, Director of Operations Exxon Valdez Oil Spill Trustee Council
Lead Trustee Agency:	All
Cost FY 95:	$522,800
Cost FY 96:	$400,000
Total Cost:	Unknown
Duration:	Ongoing
Geographic Area:	Oil spill area
Injured Resource/Service:	Multiple resources and services

INTRODUCTION

This project proposes to further develop an information management system that began with establishment of the Oil Spill Public Information Center (OSPIC) in September 1990 as a public repository for information and materials generated as a result of cleanup, damage assessment and restoration efforts following the Exxon Valdez oil spill. When fully developed, this system will make information that is relevant to the Exxon Valdez oil spill readily available for use by managers, scientists, and the public. This information will support restoration planning, management and policy making, scientific research and coordination, and public information.

NEED FOR THE PROJECT

An Information Management System supports the Mission of the Trustee Council in its efforts to restore the injured environment. Through the management, synthesis and dissemination of information and materials collected as a result of the Exxon Valdez oil spill, meaningful public participation in the restoration process, as mandated by the settlement agreement between the state and federal governments and Exxon, is facilitated.

The Oil Spill Public Information Center (OSPIC) currently serves as the central access point for information and materials generated through the Trustee Council process. Staff librarians respond to inquiries from local, state, national, and international users, including but not limited to students (from preschool to graduate school), educators, scientists, government agency personnel, state and federal legislators, environmentalists, the business community, the media, the legal profession, and other libraries and information providers.

In addition, the OSPIC staff provides priority information service to the Trustee Council, the Executive Director, the Director of Operations, the Public Information Specialist, and the staff of the Exxon Valdez Restoration Office (EVRO). Through the reference services provided to restoration project personnel, the OSPIC serves all restoration activities.

Although the OSPIC does an excellent job at distributing what information is available, it is still unclear what information has been collected, what additional information exists or would be useful, how to acquire it, who maintains it, and how to access it. This project provides an opportunity to develop a plan and the necessary tools to efficiently synthesize and disseminate this pool of information, thereby providing a lasting legacy of oil spill related work.

PROJECT DESIGN

A. Objectives

The objectives of the Information Management System are:

1. To develop a long-term strategy and guidelines to compile, manage, synthesize, and disseminate currently available information about the Exxon Valdez oil spill and the Trustee Council (including damage assessment and restoration final reports) in a manner which can easily and effectively be utilized and understood. This would include the development of an information management mission statement.

2. To develop the products and tools necessary for initial use and distribution as part of an overall strategy to provide up-to-date information on the status of restoration and recovery as well as historical knowledge of the Exxon Valdez oil spill. The first product would be an EVOS Information Summary, an interactive multimedia computer program that would allow the user to explore Exxon Valdez oil spill information.

3. To provide access to local, state, national, and international users of this information through the Oil Spill Public Information Center.

4. To coordinate the Exxon Valdez Oil Spill Trustee Council's efforts with other large data management efforts.

B. Methods

1. Integration: The Director of Operations will oversee the integration of Trustee Council-funded research in order to ensure cost-effectiveness and to maximize the ability to synthesize information and data collected from these efforts.

2. Planning: A contract will be issued to develop a long-term information management strategy. Development of such a strategy will be achieved in consultation with Trustee agencies, representatives of the public, and other users of Trustee information,

3. Coordination: The Director of Operations will oversee the coordination of Trustee Council information and data management efforts with those of other similar efforts.

4. Product development: A plan and schedule for product objectivies, identification of user needs, and testing of product design will be established, with input from an advisory group. This will include the initial phases of development of an EVOS Information Summary, an interactive computer program that will provide a current status report on restoration and recovery to date.

5. Access: The Oil Spill Public Information Center will continue in the near future as the primary repository of information on the Exxon Valdez oil spill, related events and issues, and the actions of the EVOS Trustee Council in working towards restoration of the spill affected area.

C. Schedule

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

Planning Process

Nov 94	Develop RFP for planning contract
Jan 95	Award contract
Feb 95	Establish an interagency/multidisciplinary advisory group which includes members of the public and the Public Advisory Group
Mar - May 95	Long-term information management strategy and mission statement developed
June-Oct 95	Design and preliminary development of initial information products

D. Technical Support

The analyst programmer located in the Restoration Office provides maintenance of the LAN computer network and assistance in establishing a full-text online service for the public. In addition, computer programming support and peer review will be needed in the initial product development stage and as a final review process to ensure that program development is technically correct and accurate oil spill information is presented.

E. Location

The project will be coordinated by the Director of Operations in the Anchorage EVOS Restoration Office, located at 645 G Street, Anchorage, Alaska, 99501, which is also the site of the Oil Spill Public Information Center. Users in the spill area and state, national and international users are served by mail, telephone, fax, and electronic mail.

PROJECT IMPLEMENTATION

The Oil Spill Public Information Center in Anchorage serves as the primary repository of information on the Exxon Valdez Oil Spill and the Trustee Council. The OSPIC has been an integral part of the restoration process since it was established in 1990. A major restructuring by Executive Director Jim Ayers in early 1994 has maximized library efficiency and reduced operating costs. The OSPIC Director reports directly to the Exxon Valdez Oil Spill Trustee Council's Director of Operations.

The OSPIC staff currently respond to information requests that over the past four years have totalled more than 8,500 on-site and off-site requests, In addition, OSPIC has processed 1,300 interlibrary loans of materials, performed 1,200 on-line database searches, and distributed over 16,000 documents. The OSPIC collection is cataloged in the online database of the Western Library Network (WLN), using a Novell-based local area computer network linked by modem to WLN, DIALOG, and other databases. WLN's LaserCat, a CD-ROM product, functions as the OSPIC public access catalog. In addition, the OSPIC staff uses the Internet.

The OSPIC is a repository for documents produced for and by the Trustee Council, including the Natural Resource Damage Assessment Final Reports and the Restoration Project Final Reports, meeting transcripts, agendas, budgets, work plans, correspondence, and public comments. The Trustee Council Administrative Record is maintained as a certified Administrative Record to track the decision making process of the Trustees and to address issues of accountability. The OSPIC staff distributes Trustee Council publications, such as annual reports, work plans, and information packets.

The Director of Operations will work with the Chief Scientist in developing a Request for Proposals for establishing an information management mission and long-term strategy. This plan will determine the need for additional information tools, as well as the timeline for their development, and will be developed in consultation with the public, residents of the spill area communities, the education community, the scientific research community, and others. The RFP will also include the development of the initial phases of an EVOS Information Summary, an interactive computer program.

COORDINATION OF INTEGRATED RESEARCH EFFORT

A further development of the Trustee Council's current Information Management System will go a long ways toward furthering the coordinated integration of the Trustees' research efforts This project provides a unique opportunity for all Principal Investigators to effectively disseminate the information gathered through their work to the general public, restoration staff, and the scientific community. The products generated as a result of this project have the potential to tie all EVOS-related research and historical information together into a meaningful picture for the lay person, scientist, and manager alike. This project must be closely coordinated with the Trustee Council's other major information management project - 95320J.

FY 95 BUDGET ($K) - 95089A		95089B
Personnel	159.0	
Travel	1.3	1.0
Contractual	97.8	200.0
Commodities	15.5	1.0
Equipment	20.5	2.0
Subtotal	274.1	204.0
Gen. Admin.	30.7	14.0
Total	304.8	218.0

I. EXXON VALDEZ OIL SPILL BRIEF PROJECT DESCRIPTION

Project Title: Restoration of PWS Natural Spawning Salmon Resources and Services Overview: An Integrated and Collaborative Approach

Sub-project Numbers: 95093-A; 95093-B; 95093-C

Project Leader: Howard Ferren, Special Projects Manager

Lead Agency: AK. Dept. of Fish and Game (ADF&G)

Cost of Subprojects: **FY95:** $3,948.5; **FY96** $3957.2
(NOTE: FY cost is not additive as indicated above. Should all subprojects -A, -B and -C be funded, total cost will be reduced to $2,410.9 due to integrations and cost savings.)

Start/Completion: January, 1995 - September, 1995

Project Duration: 0.75 yr.

Geographic Area: Prince William Sound

Contact Person: Howard Ferren, Special Projects Manager
PWSAC, P.O. Box 1110, Cordova, AK 99574
(907) 424-7511

II. Introduction

Due to the **Exxon Valdez Oil Spill (EVOS)**, natural spawning stocks of salmon in Prince William Sound (PWS) are recognized as injured. Pink salmon in particular are identified as injured and not recovering (**EVOS** Trustee Council). As a result of these injured resources, individuals and communities of PWS have suffered lost or reduced services. Restoration funds must be used "...for the purposes of restoring, replacing, enhancing or acquiring the equivalent of natural resources injured as a result of the oil spill or the reduced or lost services provided by such resources".

The purpose of this suite of subprojects is to rehabilitate injured natural spawning salmon stocks to maintain the biodiversity of the PWS ecosystem, and restore resources and services to subsistence, commercial, recreational and other users and communities of the PWS area. This will be accomplished by integrating objectives under a collaborative agreement between professional and local resident partners, to:

95093-A/	actively rehabilitate injured stocks;
95093-B/	reduce harvest pressures on injured wild stocks;
95093-C/	replace injured salmon resources with stocks important to subsistence users.

III. Need for Project

This integrated project is needed to: restore injured pink salmon resources by direct rehabilitation intervention in 3 oiled streams; reduce harvest pressures on injured resources to allow their recovery; and, replace lost resources and services by rehabilitating 3 streams in unoiled areas important to subsistence users in order to provide continued services to the people and communities of Prince William Sound.

IV. Objectives

A. Restore natural spawning salmon resources and services in PWS to pre-spill conditions.

B. Maximize fitness (both biologic and economic) of injured natural spawning stocks through application of knowledge of salmon population biology, genetics and disease.

C. Reduce harvest of injured natural spawning stocks by more specific management of natural spawning and hatchery stocks.

D. Develop, train and use resident expertise to establish the capability for continuing conservation and protection of PWS salmon resources.

V. Methods

Methods include:

- resource inventory (literature search and ground surveys), and resource assessment (census, phenotypes);
- genetic and disease evaluations;
- taking injured and non-injured stock for brood; isolating and incubating eggs at PWS supplementation facilities, and returning fry to natal streams for acclimation;
- monitoring the fitness of salmon stocks and their progress toward restoration;
- identification of locations to remote release hatchery salmon and initiation of test fishing to determine wild stock presence.

These methods, particularly the research and monitoring aspects, follow in concept a model for monitoring interactions of wild and hatchery salmon recently set forth by an international panel of salmon geneticists and conservation scientists convened by NINA (Norweg. Instit. Nature Res.). They emphasize the necessity of monitoring a baseline of genetic and fitness (phenotypic) data, of understanding the extent of gene flow between stocks, and of studying the biological effect of gene flow through quantitative genetic analysis.

The proposed subprojects and methods support and in many cases depend on the integrated cooperation of projects independently proposed by other agencies and groups including 95076, 95191-A, 95320-C, 95320-B, 95320-D. A workshop is proposed to bring project 95093 (A-C) collaborators and other EVOS Trustee Council funded project leaders together to further integrate and plan activities.

VI. Schedule for FY95

NOTE: The generalized schedule for the integrated subprojects is presented below for FY95. Specific objectives and activities are intended to occur annually and to encompass two (2) life cycles for both odd year and even year pink salmon. Specific subproject schedules are presented in 95093 (A-C) brief project descriptions. A generalized listing of the extended workplan and timeline is presented in **Figure 1.**

Activity	Begin	End
Convene workshop		
Contact all collaborators	1/95	1/95
Convene workshop	2/95	2/95
Integrate objectives/activities	2/95	2/95
Finalize workplans	2/95	3/95
Evaluate hatchery capabilities		
Analyze facilities' water temperature and water flows	1/95	2/95
Review incubation and facility floor plans	2/95	3/95
Compute species/stock limitations	2/95	3/95
Report on recommendations	3/95	4/95
Investigate literature		
Research oiled streams	1/95	2/95
Assess hatchery release criteria	1/95	4/95
Identify subsistence stocks	1/95	2/95
NEPA requirements		
Complete NEPA requirements	2/95	4/95
Develop technical teams for 5 sectors in PWS		
Contract vessels and crews	1/95	4/95
Contract technicians	3/95	4/95
Train field crews	4/95	5/95
Inventory stock baselines		
Stock surveys	6/95	10/95
Census/phenotypes	6/95	10/95
Collect Tissue samples	6/95	10/95
Assess stream conditions		
Collect oiled stream gravel samples	6/95	7/95
Analyze samples	6/95	8/95
Direct restoration		
Collect eggs from oiled and non-oiled streams	7/95	10/95

Activity	Begin	End
Incubate embryos	9/95	12/95
CWT/otolith mark embryos	9/95	10/95
Pen rear, acclimate & release fry	*1996*	
Recover marks/tags	*1997*	
Evaluate & revise plan	*1997*	
Reduce harvest pressure on injured stocks		
Survey sites	4/95	5/95
Test fish sites	8/95	9/95
Identify early run broodstocks	6/95	8/95
Feasibility scale releases of current hatchery production	*1996*	
Evaluate releases/returns	*1997*	
Remote egg takes early run brood	*1997*	(odd year)
Incubate and release	*1998*	
Geneflow field experiment		
Establish genetic tag (2 camps/screen males)	7/95	9/95
Sample returns	*1997*	
Analyze gene flow	*1997*	
Report	*1998*	
Quantitative genetic analysis of fitness traits		
Sample gametes in field	7/95	10/95
Incubate embryos in lab and gather data	10/95	*1996*
Analyze	*1996*	
Report	*1997*	
Model fitness effects of genetic interactions: develop simulation models for:		
Gene flow and drift	2/95	11/95
Single locus selection	7/95	*1996*
Quantitative/fitness trait	12/95	*1997*
Population dynamics	*1996*	*1997*
Report	9/95	10/95

VII. Technical support

Technical support will include the services of:

- PWSAC project management & fish culture staff
- ADF&G biologists and technicians
- University of Alaska geneticists
- ADF&G pathologist

- permitting agencies including ADF&G, Department of Army, Corps of Engineers, Department of Natural Resources
- ADF&G otolith mark analysis lab

VIII. Location

This project will take place in Prince William Sound. Field crew activities will take place within districts of PWS as divided into five sectors **(Figure 2)** including the Southeastern, Eastern, Northern-Coghill-Northwestern, Southwestern and Montague Districts.

IX. Project Implementation

PWSAC will implement the project in conjunction with the Native Village of Eyak Tribal Council, University of Alaska, School of Fisheries and Ocean Sciences, and with ADF&G as the lead agency.

X. Coordination of Integrated Research Effort

PWSAC will be responsible for coordinating activities under this proposal including research, restoration and monitoring. Activities of the salmon restoration program will be integrated with previously funded and proposed genetic investigations, stream analyses, stock identification and monitoring studies, and otolith marking **(Figure 3)**.

XI. Public Process

PWSAC is a regional association which by law (AS 16.05.380.) must include on their boards representatives of sport fishermen, municipalities, and Native organizations, in addition to commercial fishermen and processors. It is PWSAC's mission to optimally produce salmon for the benefit of all user groups.

As a mechanism to restore PWS salmon resources and services, the salmon restoration project will incorporate existing research results achieved through projects previously and currently funded by the EVOS Trustee Council process. In addition, specific stock and stream restoration options may be recommended by users and village residents within PWS. Local vessels, skippers and crews will be solicited from interested public and contracted for training and field work.

XII. Budget

Total budget for subprojects 95093 A-C

	PWSAC	EYAK	UAF	ADF&G
100 Personnel	$352.4	$387.9	$553.5	$0.0
200 Travel	$68.5	$57.8	$21.6	$0.0
300 Contractual Services	$30.0	$649.5	$48.0	$200.0
Administration	$97.2	$172.6	$335.7	$4.1
400 Commodities	$76.0	$80.2	$120.0	$0.0
500 Equipment/capital	$118.0	$25.5	$600.0	$0.0
BUDGET SUBTOTALS	**$742.1**	**1,323.5**	**1,678.8**	**204.1**
TOTAL PROJECT BUDGET	**$3,948.5**			

PLEASE NOTE:

This budget depicts all three subprojects as though their budgets were additive (separate and independently funded projects). If all three subprojects (-A, -B, -C) are funded simultaneously, cost savings are realized due to elimination of activities and cost duplications. Funding all three projects will reduce the total budget to $2,410.9. Discussion is attached to each subproject budget regarding project integration cost savings.

Figure 1: Time-line and activities

(\pwsac\evos\fig95-2)

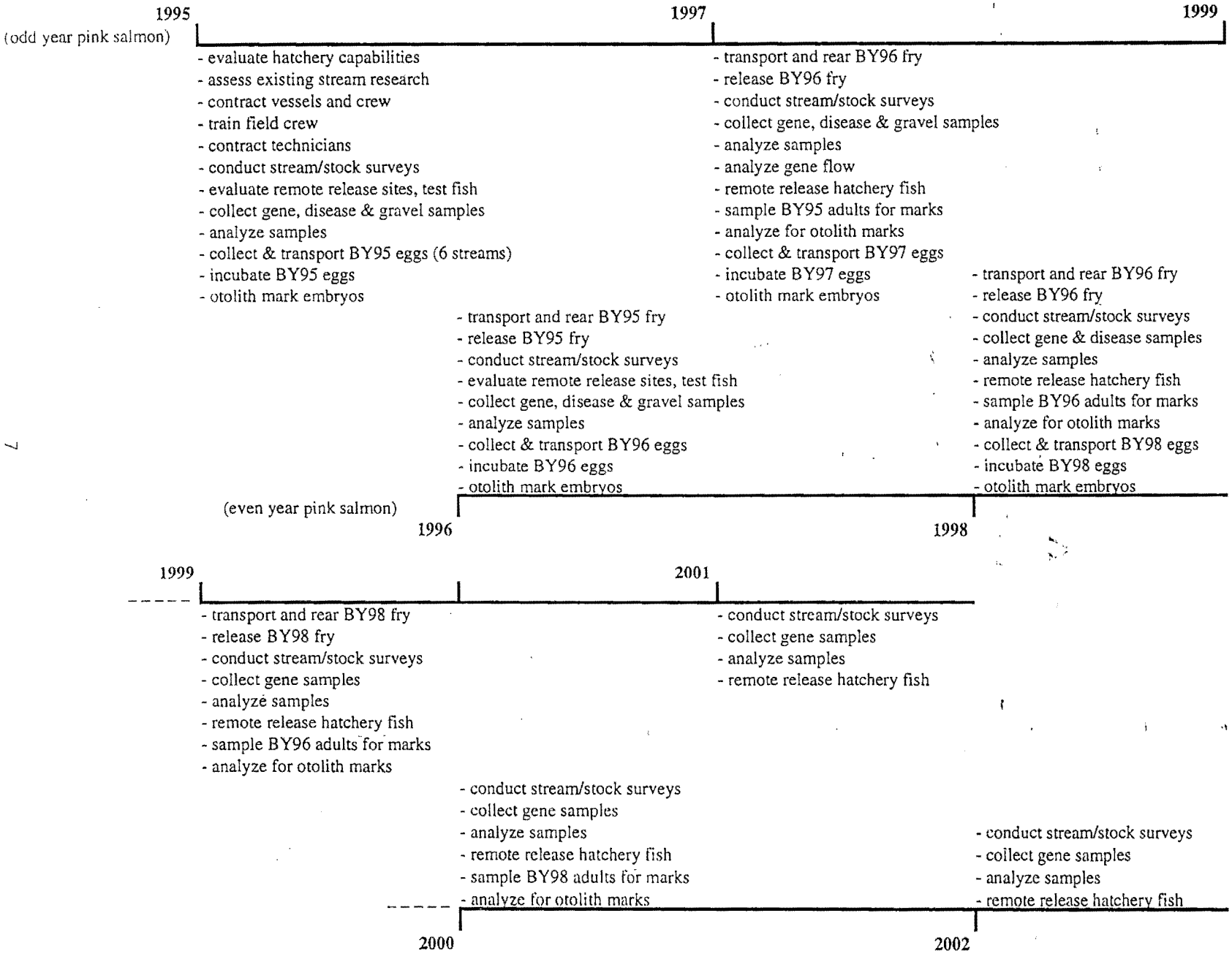
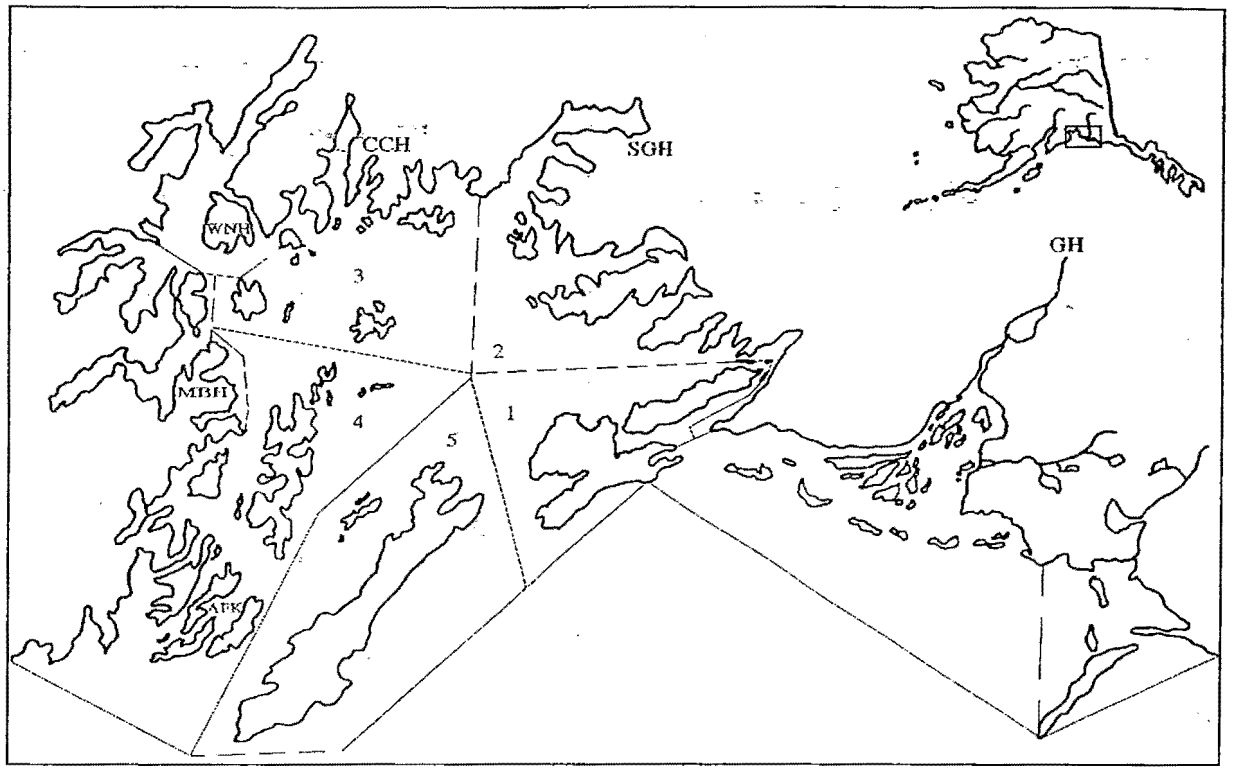


Figure 2

Prince William Sound

Sectors for Research, Restoration and Monitoring



Sectors	Hatcheries
1: Southeastern District	_____
2: Eastern District	Solomon Gulch
3: Northern-Northwestern-Coghill Districts	Cannery Creek Wally Noerenberg
4: Southwestern-Eshamy Districts	Main Bay Armin F. Koernig
5: Montague District	_____

Figure 3: Integration of Research, Restoration and Monitoring

(pwsac\evos\fig95-3)

COMPONENT	ACTIVITY	INTEGRATION
Research	Stream - stock identification	ADF&G USFS PWS resource users
Research	Stream - stock surveys and escapement enumeration	PWSAC ADF&G Trained technicians and vessel crews
Research	Genetic and disease sampling	University of Alaska, SFOS ADF&G Technicians
Research	Gene analysis; gene flow simulation	University of Alaska, SFOS ADF&G NMFS: Auke Bay Lab
Research	Disease analysis	ADF&G
Research	Evaluate remote release sites for hatchery fish	PWSAC ADF&G
Restoration	Egg-take from wild stock system(s)	PWSAC ADF&G technicians Vessel crews
Restoration	Incubation and rearing wild stock	PWSAC
Restoration	Acclimate and release wild stock	PWSAC Vessel crews
Restoration	Remote release hatchery fish	PWSAC ADF&G
Research	CWT/otolith marking	ADF&G PWSAC
Research and monitoring	Adult return, enumeration and CWT/otolith mark sampling	PWSAC ADF&G technicians Vessel crews
Research and monitoring	Otolith analysis	ADF&G

I. EXXON VALDEZ OIL SPILL BRIEF PROJECT DESCRIPTION

Subproject Title:	Restoration of Salmon in 3 Oil Damaged Streams
Project Number	95093-A
Project Leader:	Howard Ferren, Special Projects Manager
Lead Agency:	AK. Dept. of Fish and Game (ADF&G)
Cost of Project	**FY95:** $1,009.6 **FY96** $1,021.0
Start/Completion:	January, 1995 - September, 1995
Project Duration:	0.75 yr.
Geographic Area:	Prince William Sound
Contact Person:	Howard Ferren, Special Projects Manager PWSAC, P.O. Box 1110, Cordova, AK 99574 (907) 424-7511

II. Introduction

Following the *Exxon Valdez* oil spill **(EVOS)** Alaska Department of Fish and Game (ADF&G) initiated surveys in Prince William Sound (PWS) and found 106 oiled anadromous streams[1] . In 1989 21 streams of the total were determined to be heavily oiled. This number declined due to directed clean up actions and natural weathering, and as recently as 1991 only 2 streams were determined to be heavily oiled. However, lightly oiled streams increased to 26. Much of the oil remained subsurface.

Pink salmon egg mortality was observed in oiled streams in 1989 and was shown to average 15%, whereas mortality in nonoiled streams was 9%.[2]. Egg mortality has generally increased and in 1991 there was an approximate 40% to 50% egg mortality in oiled streams and 18% mortality in nonoiled streams.[2] Oil related genetic damage may be the cause of this mortality which has resulted in a substantial decrease in adult pink salmon run strength. Oil damage to pink salmon may have reduced the adult population and some experts estimate that recovery will take more than a decade.[2] In addition, direct oiling of streams and clean-up activities such as hot water washing, substrate tilling and bio-remediation may contribute to habitat degradation.

III. Need for Project

Damaged pink salmon stocks in PWS must be restored to maintain the biodiversity of the PWS ecosystem and restore spawning populations of pink salmon to pre-spill conditions.

This project will test the feasibility of supplementing oil damaged pink salmon stocks by increasing survival at early life stages and thereby increasing naturally occurring adult populations to optimally seed the available habitat.[3] Supplementation is defined as the stocking of fish into the natural habitat to increase the abundance of naturally reproducing fish populations. Use of supplementation facilities will be employed to incubate eggs (cf Draft EIS, Proposed Action, Comprehensive Restoration of Impacts on Fish, Action 3, Ch. 4, p. 124).

Targeting three oiled streams for supplementation will allow us to test supplementation as a possible tool for restoring damaged populations. In addition to testing this procedure, important biological traits of damaged populations will be inventoried and assessed, as well as substrate hydrocarbons, and geneflow through subsequent generations of the population.

IV. Objectives

A. Test supplementation as a useful tool to restore injured pink salmon stocks in oiled streams.

B. Restore naturally spawning pink salmon populations in oil damaged streams to pre-spill conditions.

C. Maximize fitness (both biologic and economic) of injured wild stocks through application of knowledge of salmon population biology, genetics and disease.

V. Methods

1. **Inventory and assessment:** This component will have both literature and in-field aspects. Habitat will be identified, inventoried and assessed as to candidate oiled streams. Injured pink salmon stocks will be censused and inventoried for phenotype and genotype. Samples will be taken for pathogen and parasite assessment. Facilities will be assessed for water regime requirements and possible modifications to suit feasibility scale supplementation.

2. **Implementation:** Implementation will have several phases including stream survey, substrate sampling, brood stock collection and sampling, eggtake, egg transport to supplementation facility, incubation, thermal marking, return of fry to natal stream for net pen rearing and acclimation. All necessary permitting including hatchery permit alterations (PAR), fry transport permits (FTP), Alaska Coastal Consistency Review, DNR Tideland's lease and bonding, Army Corps anchoring permit, and U.S. Coast Guard anchoring permit must be obtained. The project will be reviewed after one return cycle of both odd and even year pink salmon and a decision made to either continue or discontinue the feasibility project, or go to larger scale supplementation.

3. **Evaluation:** Supplementation will be evaluated as a tool for restoring pink salmon stocks by determining and comparing natural versus supplementation egg to fry survivals, acclimation success by adult homing, and adult survivals for seeding the habitat. Stocks selected for subsistence restoration **(95093-C)** will provide the **control experiments** needed for the oiled stream supplementation

feasibility subproject and genetic research. Integral with the supplementation process will be:

a. Straying/gene flow field experiment: (SFOS Division of Fisheries)
This research is modelled on earlier work on pink salmon at Auke Creek in Juneau by A.J. Gharrett and colleagues. Straying may be estimated by observing physically marked or tagged salmon; however, straying is only one component of gene flow--strays may well not breed successfully to contribute genetically. Our proposed protocol is to screen male returning salmon at a weir, allowing about 20%, those bearing a relatively rare presumably neutral gene, to spawn naturally. This procedure genetically tags the stock; applied with different marker genes to two stocks in the same region, a precise estimate of actual gene flow can be obtained by simple monitoring of the stocks over several generations. Integrates with Project Proposal 95076 by Wertheimer, et al.

b. Fitness phenotype laboratory experiment: quantitative genetic analysis of life history and fitness traits. (SFOS Division of Fisheries)
This research is developed from earlier work on pink salmon at Auke Creek and at Gastineau Hatchery by W.W. Smoker, P.A. Crandell, and colleagues. Gametes sampled from known parents in stocks under restoration will be taken to the incubation laboratory at Juneau and observed under a standard quantitative genetic experimental design. Analysis of observations of fitness-related developmental traits (rates of development, salinity tolerance, etc.) and developmental stability (fluctuating asymmetry of meristic and morphologic traits) will provide estimates of genetic parameters, and from observations of hybrid families, direct estimates of the fitness effects of gene introgression.

c. Analysis of fitness effects on natural spawning stocks of interactions with cultured fish based on observed PWS data. (SFOS Division of Fisheries)
Recent biometrical simulations of hypothetical salmon production systems, modelled on PWS pink salmon, by AJ Gharrett have demonstrated a relationship between ecological productivity (carrying capacity) and the overall fitness benefit of homing or straying. These models will provide a basis for analyzing with biometrical rigor the straying, gene flow, population genetic structure, and quantitative fitness variation data collected by other components of this integrated project.

Requisite to a thorough evaluation of the supplementation process, fish incubated at facilities must be marked for later identification. Therefore, additional methods employed in this subproject must include:

a. Coded micro wire tagging: Refer to Project Proposal 95137, 95320: Stock ID and Monitoring Studies.

b. Thermal manipulation of otolith microstructure Contained in Project Proposal 95320C, Otolith thermal mass marking.

4. **Logistics:** Logistical support will be provided by the Native Village of Eyak Tribal Council and include locally owned vessels with local resident crews and technical teams. Inventories, sampling, egg takes, pen rearing acclimation, and other activities will involve the logistical support services.

One vessel and team will be required for habitat assessment, salmon stock inventory, fish sampling and eggtake. Three vessels and crews will be required during fry pen rearing and acclimation. A detailed cooperative agreement established between PWSAC, Native Village of Eyak Tribal Council, and UAF-SFOC establishes the collaborative responsibilities.

VI. Schedule for FY-95

NOTE: The schedule is presented for FY95. Specific objectives and activities are intended to occur annually to encompass two (2) life cycles for both odd year and even year pink salmon.

Activity	Begin	End
Evaluate hatchery capabilities		
Analyze facilities' water temperature and water flows	1/95	2/95
Review incubation and facility floor plans	2/95	3/95
Compute species/stock limitations	2/95	3/95
Report on recommendations	3/95	4/95
Literature search		
Review literature	1/95	2/95
Identify injured stocks for supplementation activities	2/95	2/95
NEPA compliance		
Complete NEPA requirements	2/95	4/95
Develop and deploy logistical support		
Contract vessels and crews	5/95	5/95
Contract technicians	5/95	6/95
Train field crews	5/95	6/95
Inventory and assessment		
Stock surveys	7/95	10/95
Census/phenotypes	7/95	10/95
Take fish samples	7/95	10/95
Analyze for pathogens/parasites	8/95	9/95
Assess stream conditions		
Collect oiled stream gravel samples	6/95	7/95
Analyze samples	6/95	8/95

Activity	Begin	End
Direct restoration		
Collect eggs from oiled streams	8/95	9/95
Incubate embryos	9/95	12/95
CWT/otolith mark embryos	9/95	10/95
Pen rear, acclimate & release fry	*1996*	
Recover marks/tags	*1997*	
Evaluate & revise plan	*1997*	
Geneflow field experiment		
Establish genetic tag	7/95	9/95
Sample returns	*1997*	
Analyze gene flow	*1997*	
Report	*1998*	
Quantitative genetic analysis of fitness traits		
Sample gametes in field	7/95	10/95
Incubate embryos in lab and gather data	10/95	*1996*
Analyze	*1996*	
Report	*1997*	
Model fitness effects of genetic interactions: develop simulation models for:		
Gene flow and drift	2/95	11/95
Single locus selection	7/95	*1996*
Quantitative/fitness trait	12/95	*1997*
Population dynamics	*1996*	*1997*
Report	9/95	10/95

VII. Technical support

Technical support will include the services of:

- PWSAC planning, project management and fish culture staff
- ADF&G biologists and technicians
- University of Alaska geneticists
- ADF&G pathologist
- permitting agencies including ADF&G, Department of Army, Corps of Engineers, Department of Natural Resources
- ADF&G otolith mark analysis lab

VIII. Location

This project will take place in Prince William Sound. Specific streams in the oiled area, particularly the Southwestern District, will be selected as sites for supplementation.

IX. Project Implementation

PWSAC will implement the project in conjunction with the Native Village of Eyak Tribal Council, University of Alaska, School of Fisheries and Ocean Sciences, and with ADF&G as the lead agency.

X. Coordination of Integrated Research Effort

PWSAC will be responsible for coordinating activities under this proposal including research, restoration and monitoring. Activities of the oiled injured stock restoration subproject will be integrated with previously funded and proposed genetic investigations, stream analyses, stock identification and monitoring studies, and otolith marking.

XI. Public Process

PWSAC is a regional association having representatives from various user groups, communities and businesses seated as the Board of Directors. The Board has authorized this subproject and suite of salmon projects under the title of Restoration of PWS Natural Spawning Stock Salmon Resources and Services Overview: An Integrated and Collaborative Approach. The project has had wide exposure and endorsement throughout PWS. In addition, **NEPA** requirements will be met prior to stream supplementation activities.

XII. Personnel Qualifications

PWSAC

B. Roys
President, CEO
B.S. Wildlife Management, University of Massachusetts
Fisheries biology, fisheries management, organizational management.

H.J. Ferren
Special Project Manager, Planner
M.S. Biological Oceanography, University of Alaska
Corporate strategic and tactical planning, regional salmon planning, team facilitation and project management.

Eric Prestegard
Fisheries Manager
A.A. Fisheries
Fish culture, fisheries research, quality control, fisheries management.

C. Kerns
Principal Fish Culturist
M.S. Fisheries Biology, Michigan State University
Chairman Alaska Fisheries Council (1979-83); President American Fisheries Society (1983-84); Certified Fisheries Scientist; Former Associate Professor, University of Alaska; Management in fish nutrition research.

Native Village of Eyak Tribal Council

B. Henrichs
President
Native; fisherman; vessel coordination and logistics.

D. Daisy
B.S. Fisheries, University of Massachusetts
Fisheries Rehabilitation Program Manager (ADF&G); Consultant in fisheries development and aquaculture.

University of Alaska, SFOS

W.W. Smoker
Professor of Fisheries, SFOS.
PhD Fisheries, Oregon State Univ.
Research in salmon ocean ranching, quantitative genetics of Pacific salmon.

A.J. Gharrett
Professor of Genetics, SFOS
PhD Genetics, Oregon State Univ
Research on molecular genetics, population genetics of Pacific salmon.
Recognized expert on population genetics of Pacific salmon, Genetic Stock Identification, genetic tagging

Patricia A. Crandell
Postdoctoral Fellow and Research Associate, SFOS
PhD Aquaculture Genetics, Biometrics Univ. of Calif Davis
Research on quantitative genetics of pink salmon, ploidy manipulation in Pacific salmon
Expertise in experimental design and statistical analysis.

Andrew Gray
Research Associate, SFOS
MS Genetics, Washington State University
Molecular genetics techniques, Electrophoretic analysis of allozymes, DNA analysis

XIII. Budget

Subproject 95093-A

	PWSAC	EYAK	UAF	ADF&G
100 Personnel	$80.5	$129.3	$184.5	$0.0
200 Travel	$19.1	$12.6	$7.2	$0.0
300 Contractual Services	$0.0	$61.5	$16.0	$75.0
Administration	$16.0	$32.4	$111.9	$0.8
400 Commodities	$7.0	$4.3	$40.0	$0.0
500 Equipment/capital	$0.0	$8.5	$200.0	$0.0
PROJECT BUDGETS	**$122.5**	**$248.6**	**$559.6**	**$78.8**
TOTAL PROJECT BUDGET	**$1,009.6**			

NOTE: If Subproject-C is funded, then cost of Subproject-A is reduced to $280,750 by elimination of activities and cost duplications. Conversely, if A if funded, then costs of Subproject-C are reduced to similar amount. Total cost if both A and C are funded is $1,290,229. Funded separately, the projects will cost in excess of $2,000,000.

References

1. Alaska Department of Fish and Game, *Exxon Valdez* Oil Spill Response Operations Report - Habitat Division 1989-1992. June 1992.

2. Draft *Exxon Valdez* Oil Spill Restoration Plan. *Exxon Valdez* Oil Spill Trustee Council. 1993.

3. The Use of Supplementation to Aid in Natural Stock Restoration. Cuenco, M., Backman, T., and Mundy, P. Columbia River Inter-Tribal Fish Commission.

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EXXON VALDEZ TRUSTEE COUNCIL
1995 Federal Fiscal Year Project Budget
October 1, 1994 - September 30, 1995

Project Description: **Restoration of salmon in 3 oiled streams** targets natural spawning stock restoration through a program of stock inventory, supplementation and genetics investigtion. The project is designed as a feasibility program to evaluate the potential for supplementation as a means to restore oil injured stocks. The project will also allow us to research key genetic concerns including geneflow through the population and quantitative gene analysis.

Budget catagory	1994 Project No. Authorized FFY 94	94 Report/ 95 Interim* FFY 95	Remaining Cost** FFY 95	Total FFY 95	FFY 96	Comments
Personnel	$0.0	$0.0	$346.4	$346.4	$361.0	- primary cost assoc with genetics research
Travel	$0.0	$0.0	$38.8	$38.8	$38.8	- can be reduced by shared air charters
Contractual	$0.0	$0.0	$152.5	$152.5	$247.0	- increases in 1996 with added vessels
Commodities	$0.0	$0.0	$32.3	$32.3	$36.3	- assoc. with science, field work & vessels
Equipment	$0.0	$0.0	$108.5	$108.5	$69.0	- 1995 experiments eqpmt; 1996 net pens
Capital Outlay	$0.0	$0.0	$0.0	$0.0	$0.0	
Subtotal	$0.0	$0.0	$678.5	$678.5	$752.1	
General Administration	$0.0	$0.0	$127.1	$127.1	$133.5	- PWSAC/EYAK @ 15%; UAF @ 25%
Project Total	$0.0	$0.0	$805.6	$805.6	$885.6	
Full-time Equiv. (FTE)	0.0	0.0	0.0	0.0		Note: feasibility study and research projected to occur over two life cycles of both even and odd year cycle pink salmon. One life cycle will provide much towards understanding injured stock supplementation; lethal trait inheretibility, geneflow and straying. Subproject 95093-C will provide both the experiment control & subsistence restoration.
	Dollar amounts are shown in thousands of dollars					

Budget Year Proposed Personnel: Position Description	Reprt/Intrm Months	Reprt/Intrm Cost	Remaining Months	Remaining Cost
PWSAC proj leader (biologist,manager)			9.0	$46.9
PWSAC fish culturist			3.0	$13.2
PWSAC fish tech (2 @ 1mm ea)			2.0	$4.8
Eyak logistic manager, bio. coordinator, clerk			9.0	$97.0
UAF-SFOS Princ inveti.; subproj investi; researh assoc. seasonals (10); grad research assist.			60.0	$184.5
Personnel Total	0.0	$0.0	83.0	$346.4

NEPA Cost: $75.0

* Oct 1, 1994 - Dec 31, 1994

** Jan 1, 1995 - Sep 30, 1995

Project Number: 95093-A

Project Title: Restoration of Salmon in 3 Oil Damaged Streams

Agency: Prince William Sound Aquaculture Corporation

Travel	Rept/Intrm	Remaining
ANCH/CDV : 4 RT @ $300 + 3 day per diem	$0.0	$3.6
Field travel: including supplementation site visit to review facility to accommodate injured stock (6hrx$250/hr)	$0.0	$1.5
- remote travel to selected oiled streams for inventory and assessment (4 RT @ $250/hr x 3hr)	$0.0	$3.0
- air transport gravel/fish samples (3 RTx $250/hr x 3 hr);	$0.0	$2.3
- transport fish techs and eggs to supplementation facility (12 RTx $250/hr x 3 hr);	$0.0	$9.0
- UAF researcher travel	$0.0	$7.2
- project leader remote travel (2RT x $250/hr x 6hr)	$0.0	$3.0
- logistics manager remote travel (2RT x $250/hr x 6h)		$3.0
- biological coordinator remote travel (6RT x $250 x 4hr)		$6.0
Travel Total	$0.0	$38.6
Contractual		
Eyak: vessel contract @ $1,500/day x 41 days	$0.0	$61.5
UAF-SFOS: contract for laboratory/facilities and use	$0.0	$16.0
ADF&G: NEPA compliance(3 EAs @ $25,000)	$0.0	$75.0
Contractual Total	$0.0	$152.5

Project Number: 95093-A
Project Title: Restoration of Salmon in 3 Oil Damaged Streams
Agency: Prince William Sound Aquaculture Corporation

Commodities:	Rept/Intrm	Remaining
PWSAC: field supplies including sample containers, gloves, note books, nets/seines, sampling tools, tags, electro shocker.	$0.0	$7.0
EYAK: office supplies; vessel commodities for crew ($15/person/day).	$0.0	$4.3
UAF-SFOS: field and laboratory supplies.	$0.0	$21.0
Commodities Total	$0.0	$32.3
Equipment:		
EYAK: office equipment (computer, printer, copier)	$0.0	$8.5
UAF-SFOS: electrophoresis equipment and field camp materials.	$0.0	$100.0
Equipment Total	$0.0	$108.5

Project Number: 95093-A
Project Title: Restoration of Salmon in 3 Oil Damaged Streams
Agency: Prince William Sound Aquaculture Corporation

I. EXXON VALDEZ OIL SPILL BRIEF PROJECT DESCRIPTION

Project Title:	Diversion of Fishing Effort From Oil Damaged Salmon Stocks
Project Number:	95093-B
Project Leader:	Howard Ferren, Special Projects Manager
Lead Agency:	AK. Dept. of Fish and Game (ADF&G)
Cost of Project:	**FY95:** $1,937.9 **FY96** $1,712.5 *(Note: if funded with Subprojects -A or -B, cost will be reduced to $1,120.6)*
Start/Completion:	January, 1995 - September, 1995
Project Duration:	0.75 yr.
Geographic Area:	Prince William Sound
Contact Person:	Howard Ferren, Special Projects Manager PWSAC, P.O. Box 1110, Cordova, AK 99574 (907) 424-7511

II. Introduction

Significant pink salmon egg mortality is attributed to oiling of anadromous streams resulting from the *Exxon Valdez* oil spill **(EVOS)**. Mortality has persisted through subsequent generations contributing to a reduction in adult pink salmon returns limiting both the escapement of naturally spawning populations, and services to users and communities deriving an income from the resource.

Activities directed at restoring injured pink salmon to pre-spill conditions may include habitat protection and improvement, hatchery rearing, net-pen rearing and relocation of hatchery runs[1]. Relocation of hatchery runs can take the form of releasing fish in new locations or replacing hatchery fish with a stock of different run timing. These changes to current hatchery stocks and releases can provide alternate return locations or return timing. This in turn can reduce harvest pressures on injured stocks which might presently be caught in fisheries targeting predominantly hatchery fish.

III. Need for Project

Diversion of fishing efforts from oil damaged salmon stocks is an important step to reduce pressures on these fish while providing greater opportunity to meet spawning escapement needs. For example, hatchery salmon could be released in the Eastern, Southeastern and/or Montague Districts, thereby distributing the commercial fleet and reducing harvest pressures on injured stocks in the Eshamy, Northwestern and Southwestern Districts. Also, hatchery stocks could be replaced with stocks which have adult return run time different from that of injured or depleted wild stocks which may be currently harvested in fisheries

targeting returning hatchery salmon. By culturing temporally isolated salmon stocks, fisheries can be managed without placing additional pressure on injured stocks. Consideration must be given to species in addition to pink salmon if those species provide the temporal and spatial isolation necessary to reduce pressures on injured pink stocks.

Without taking steps to reduce these harvest pressures, and where possible the supplementation of the injured stocks, it may take many generations before restoration of stocks to pre-spill conditions can be achieved. As a result of no action, injured stocks will continue to be subject to pressures which may prevent their full contribution to the biodiversity and economy of the PWS ecosystem.

IV. Objectives

A. **Restore naturally spawning salmon resources and services in PWS to pre-spill conditions.**

B. **Maximize fitness (both biologic and economic) of injured salmon stocks through application of knowledge of salmon population biology, genetics and disease.**

C. **Reduce harvest of injured naturally spawning stocks by more specific management of wild and hatchery stocks.** Specific objectives for FY95 include: to remote release 50 million pink salmon fry in increments of 25 million at two locations; and, identify an early run timing stock of salmon which could replace current hatchery stock.

V. Methods

1. **Inventory and assessment:** This component will have both literature review and in-field aspects. Approaches to remote releasing hatchery salmon, and replacing hatchery salmon with a stock of different run timing require:
   a. hatchery stock inventory (genetic and disease history);
   b. facility assessment (water regime characteristics and capabilities);
   c. remote release location assessment (inventory of possible locations); many potential release areas have already been identified in the *Regional Comprehensive Salmon Plan, Phase 3*;
   d. naturally spawning salmon stock census by ground surveys in five districts of PWS to contribute to stock baseline information including species, stocks and stock size; identification of genotypes and frequencies from selected stocks, and phenotypes; sampling for parasites and pathogens from selected stocks; assessment of brood potentials to replace hatchery stocks;

2. **Implementation:** Implementation will have several phases.
   a. Remote releasing hatchery fish requires transportation of outmigrant fry to remote pens for rearing and acclimation. After two weeks of rearing, fry are released to the marine waters. Vessels and crews must be present on-site during the rearing phase. All necessary permitting including hatchery permit alterations (PAR), fry transport permits (FTP), Alaska Coastal Consistency Review, DNR Tideland's lease and bonding, Army Corps anchoring permit, and U.S. Coast Guard anchoring permit must be obtained.

b. Replacing current hatchery brood stock with another stock of different run timing requires PAR and FTP permitting, along with brood stock collection and introduction to the hatchery. FY95 funding will be directed at stock identification, permitting and initial brood sampling if feasible.

3. **Evaluation:** Critical to the success of either remote release hatchery fish or developing a new run timing stock is the evaluation program. Elements of the evaluation program include:

a. test fishing to determine whether natural stocks migrate through the proposed fishing area surrounding a remote release location, and the interception rate;

b. CWT/otolith marking fish to evaluate return run strength, and straying; Coded micro wire tagging: Refer to Project Proposal 95137, 95320: Stock ID and Monitoring Studies. Thermal manipulation of otolith microstructure Contained in Project Proposal 95320C, Otolith thermal mass marking.

c. genetic monitoring to determine whether geneflow occurs between remote released fish and natural spawning populations in the area of the remote release.

d. analysis of harvest stock composition to determine at what level injured stocks are being harvested both pre and post hatchery releases.

4. **Logistics:** Logistical support will be provided by the Native Village of Eyak Tribal Council and include locally owned vessels with local resident crews and technical teams. Inventories, census, fish sampling, eggtakes, pen rearing acclimation, and other activities will involve the logistical support services.

One vessel and team will be required for inventory, assessment and sampling in each of five sectors as described in the overview proposal. Historic observations indicate that early returning salmon stocks spawn in the Eastern and Southeastern Districts. Therefore, two vessels and technical teams are to be deployed to those sectors from June 15 through July 31. Beginning August 1, five vessels and crews are to be deployed, one to each sector of PWS during the mid and late salmon return, and remain in the field until September 25. The project leader and field technicians trained and assigned to each vessel and sector will survey, sample, monitor, compile data and report as required. Additional assignments may include, based on restoration requirements, taking eggs, managing net pens, rearing fry for acclimation, or other restoration activities.

A detailed cooperative agreement established between PWSAC, Native Village of Eyak Tribal Council, and UAF-SFOS establishes the collaborative responsibilities.

VI. Schedule for FY95

Activity	Begin	End
Evaluate hatchery capabilities		
Analyze water temp. and flow	1/95	2/95

Activity	Begin	End
Review incubation and facility floor plans	2/95	3/95
Compute species/stock limitations	2/95	3/95
Report on recommendations	3/95	4/95
Literature search		
Review literature	1/95	2/95
Identify remote release sites and possible early run salmon stocks	2/95	2/95
NEPA compliance		
Complete NEPA requirements as required	2/95	4/95
Develop and deploy logistical support		
Contract vessels and crews	5/95	5/95
Contract technicians	5/95	6/95
Train field crews	5/95	6/95
Deploy vessels	6/95	10/95
Inventory and assessment		
Stock/stream surveys	6/95	10/95
Census/phenotypes	6/95	10/95
Take fish samples/genotypes	6/95	10/95
Analyze for pathogens/parasites	6/95	10/95
Remote release hatchery fish		
Permitting as required	2/95	5/95
Deploy net pens	5/95	5/95
Transport fry	5/95	5/95
Pen rear, acclimate & release fry	5/95	5/95
Recover marks/tags	*1996*	
Evaluate & revise plan	*1996*	
Evaluate remote terminal harvest area		
Test fish area	8/95	9/95
Evaluate migrating stock interception rate	9/95	10/95
Identify early run time brood stock		
Review phenotype inventory	6/95	7/95
Assess stock population	7/95	8/95
Permitting as required	6/95	9/95
Take eggs to initiate hatchery brood replacement	7/95	9/95
Report	9/95	10/95

VII. Technical support

Technical support will include the services of:

- PWSAC planning, project management and fish culture staff
- ADF&G biologists and technicians
- University of Alaska geneticists
- ADF&G pathologist
- permitting agencies including ADF&G, Department of Army, Corps of Engineers, Department of Natural Resources
- ADF&G otolith mark analysis lab

VIII. Location

This project will take place in Prince William Sound. Specific locations for remote releasing hatchery salmon are yet to be determined. Stock inventories will take place throughout 5 sectors delineating PWS for this subproject.

IX. Project Implementation

PWSAC will implement the project in conjunction with the Native Village of Eyak Tribal Council, University of Alaska, School of Fisheries and Ocean Sciences, and with ADF&G as the lead agency.

X. Coordination of Integrated Research Effort

PWSAC will be responsible for coordinating activities under this proposal including research, restoration and monitoring. Activities of the oiled injured stock restoration subproject will be integrated with previously funded and proposed genetic investigations, stream analyses, stock identification and monitoring studies, and otolith marking.

XI. Public Process

PWSAC is a regional association which by law (AS 16.05.380.) must include on their boards representatives of sport fishermen, municipalities, and Native organizations, in addition to commercial fishermen and processors. It is PWSAC's mission to optimally produce salmon for the benefit of all user groups.

As a mechanism to restore PWS salmon resources and services, the PWSAC salmon restoration project will incorporate existing research results achieved through projects previously and currently funded by the EVOS Trustee Council process. In addition, NEPA and agency permitting processes are open to public review. Further, remote release projects will be reviewed by the PWS/Copper River Regional Planning Team which conducts business in a public forum for open discussion at the planning phase of project definition.

XII. Personnel Qualifications

PWSAC

B. Roys
President, CEO
B.S. Wildlife Management, University of Massachusetts
Fisheries biology, fisheries management, organizational management.

H.J. Ferren
Special Project Manager, Planner
M.S. Biological Oceanography, University of Alaska
Corporate strategic and tactical planning, regional salmon planning, team facilitation and project management.

Eric Prestegard
Fisheries Manager
A.A. Fisheries
Fish culture, fisheries research, quality control, fisheries management.

C. Kerns
Principal Fish Culturist
M.S. Fisheries Biology, Michigan State University
Chairman Alaska Fisheries Council (1979-83); President American Fisheries Society (1983-84); Certified Fisheries Scientist; Former Associate Professor, University of Alaska; Management in fish nutrition research.

Native Village of Eyak Tribal Council

B. Henrichs
President
Native; fisherman; vessel coordination and logistics.

D. Daisy
B.S. Fisheries, University of Massachusetts
Fisheries Rehabilitation Program Manager (ADF&G); Consultant in fisheries development and aquaculture.

University of Alaska, SFOS

W.W. Smoker
Professor of Fisheries, SFOS.
PhD Fisheries, Oregon State Univ.
Research in salmon ocean ranching, quantitative genetics of Pacific salmon.

A.J. Gharrett
Professor of Genetics, SFOS
PhD Genetics, Oregon State Univ
Research on molecular genetics, population genetics of Pacific salmon.
Recognized expert on population genetics of Pacific salmon, Genetic Stock Identification, genetic tagging.

Patricia A. Crandell
Postdoctoral Fellow and Research Associate, SFOS
PhD Aquaculture Genetics, Biometrics Univ. of Calif Davis
Research on quantitative genetics of pink salmon, ploidy manipulation in Pacific salmon
Expertise in experimental design and statistical analysis.

Andrew Gray
Research Associate, SFOS
MS Genetics, Washington State University
Molecular genetics techniques, Electrophoretic analysis of allozymes, DNA analysis

XIII. Budget

Subproject 95093-B

	PWSAC	EYAK	UAF	ADF&G
100 Personnel	$194.1	$129.3	$184.5	$0.0
200 Travel	$30.3	$32.6	$7.2	$0.0
300 Contractual Services	$30.0	$526.5	$16.0	$50.0
Administration	$65.2	$107.8	$111.9	$2.5
400 Commodities	$62.0	$21.6	$40.0	$0.0
500 Equipment/capital	$118.0	$8.5	$200.0	$0.0
PROJECT BUDGETS	**$499.6**	**$826.3**	**$559.6**	**$52.5**
TOTAL PROJECT BUDGET	**$1,938.0**			

NOTE: If Subprojects-A or -C are funded, then the total of Subproject-B will reduce to $1,120,636 by elimination of activities and cost duplications. This presents a saving of more than $800,000.

References

1. Final Environmental Impact Statement for the *Exxon Valdez* Oil Spill Restoration Plan. *Exxon Valdez* Oil Spill Trustee Council. 1994.

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EXXON VALDEZ TRUSTEE COUNCIL
1995 Federal Fiscal Year Project Budget
October 1, 1994 - September 30, 1995

Project Description: **Diversion of Fishing Effort From Oil Damaged Salmon Stocks** outlines a resource inventory and assessment project designed to reduce harvest pressure on injured naturally spawning stocks by relocating hatchery returns in time or location from returning injured stocks. This will allow harvesting to occur without additional pressures on injured stocks. The assessment program will identify and evaluate replacement stocks and remote release locations. Releases will begin in 1995.

Budget catagory	1994 Project No. Authorized FFY 94	94 Report/ 95 Interim* FFY 95	Remaining Cost** FFY 95	Total FFY 95	FFY 96	Comments
Personnel	$1.0	$0.0	$447.5	$447.5	$529.6	- primary cost associated with genetics research
Travel	$0.0	$0.0	$70.6	$70.6	$70.6	- can be reduced by shared air charters (est 30%)
Contractual	$0.0	$0.0	$622.5	$622.5	$622.5	- large costs associated with vessel contracts
Commodities	$0.0	$0.0	$104.6	$104.6	$129.7	- assoc. with science, fieldd work & vessels
Equipment	$0.0	$0.0	$226.5	$226.5	$126.5	
Capital Outlay	$0.0	$0.0	$0.0	$0.0	$0.0	
Subtotal	$0.0	$0.0	$1,471.7	$1,471.7	$1,478.9	
General Administration	$0.0	$0.0	$248.5	$248.5	$234.1	PWSAC/EYAK @ 15%; UAF @ 25%
Project Total	$0.0	$0.0	$1,720.2	$1,720.2	$1,713.0	
	NOTE: If 95093-B is funded with 95093-A or -C, cost for -B will reduce to $1,078.0.					
Full-time Equiv. (FTE)	0.0	0.0	0.0	0.0		Note: project will enable relocation of hatchery returns to reduce harvest pressures on injured stocks; early brood stock may also be identified for culture and replacement of late run hatchery stocks thereby further reducing harvest pressures on injured stocks as recommended in the Restoration Plan EIS.
	Dollar amounts are shown in thousands of dollars					

Budget Year Proposed Personnel: Position Description	Reprt/Intrm Months	Reprt/Intrm Cost	Remaining Months	Remaining Cost
PWSAC: project leader			9.0	$46.9
PWSAC: project biologist/culturist			9.0	$37.5
PWSAC: assistant biologist (2@100days; 3@50days)				$70.0
PWSAC: Fish techs (2@ 21 days)				$3.4
PWSAC: staff assistant				$8.7
EYAK: logistics manager, bio. coordinator, clerk			9.0	$97.0
UAF-SFOS: Princ invest,; subproj invest.; research assoc. seasonals (10); grad research assist.			60.0	$184.5
Personnel Total	0.0	$0.0	87.0	$448.0

NEPA Cost: $50.0

* Oct 1, 1994 - Dec 31, 1994

** Jan 1, 1995 - Sep 30, 1995

Project Number: 95093-B
Project Title: Diversion of Fishing Effort from Oil Damaged Salmon Stocks
Agency: Prince William Sound Aquaculture Corporation

Travel:	Rept/Intrm	Remaining
ANCH/CDV: (proj. leader, logistics manager, bio. coord) 6 RT @ $300 + 3 day per diem	$0.0	$4.4
Field travel: for proj. and logistics managers, field biologists, sample transport, etc.		
- biologist travel to review facility configuration and options		$1.5
- 5 field biologists travel during 3 month field season: (20 RT @ 3 hr @ $250/hr)		$15.0
- fish sample shipments during season (6RT @ 3hr @ $250/hr)		$4.5
- UAF researcher travel including Juneau legs and remote sites		$7.2
- project leader & biological assist. to PWSAC fisheries manager/principle fish culturist (6RT @ 6hr @ $250/hr)		$9.0
- logistics manager travel to remote sites (6 RT @ 6hr @ $250/hr)		$9.0
- biol. coordinator travel to remote sites (20 RT @ 4 hr @ $250/hr)		$20.0
Travel Total	$0.0	$70.6
Contractual		
Eyak: vessel contract @ $1,500/day		
- 2 vessels @ 52 days for early season stream surveys and stock evaluation		$156.0
- 5 vessels @ 41 days for late season stream surveys, stock evaluation; test fish remote release sites		$307.5
- 2 vessels @ 21 days for remote release site netpen rearing duty		$63.0
PWSAC: barge contract for fry transport (2 sites @ $15.0K per site)		$30.0
UAF-SFOS contract for laboratory/facilities and use		$16.0
ADF&G: NEPA compliance (2 EAs @ $25,000 ea)		$50.0
Contractual Total	$0.0	$622.5

Commodities:	Rept/Intrm	Remaining
PWSAC		
- field season ship board stream survey, stock assessment supplies		$10.0
- feed and storage at remote release sites @ 2 sites/ $20K /site		$40.0
- miscellaneous material and supplies for each remote release site @ $6K /site		$12.0
UAF-SFOS: supplies for 3 field projects		$21.0
- office supplies (paper, miscellaneous office materials)		$1.2
- vessel supplies (4 people x 2 boats x 52 days x $15/day/person)		$6.2
- vessel supplies (4 people x 5 boats x 41 days x $15/person/day)		$12.3
- vessel supplies (2 people x 2 boats x 21 days x $15/day/person)		$1.9
Commodities Total	$0.0	$104.6
Equipment:		
PWSAC		
- 3 pens ea remote release site x 2 sites x $18,000/pen		$108.0
- anchoring systems for each remote netpen complex @ $5,000 per site		$10.0
UAF-SFOS: research equipment (electrophoresis, remote camps)		$100.0
Eyak: office equipment including computer, copier, printer		$8.5
Equipment Total	$0.0	$226.5

Project Number: 95093-B
Project Title: Diversion of Fishing Effort from Oil Damaged Salmon Stocks
Agency: Prince William Sound Aquaculture Corporation

I. EXXON VALDEZ OIL SPILL BRIEF PROJECT DESCRIPTION

Project Title: Restoration of 3 Salmon Stocks Important to Subsistence

Project Number: 95093-C

Project Leader: Howard Ferren, Special Projects Manager

Lead Agency: AK. Dept. of Fish and Game (ADF&G)

Cost of Project: **FY95:** $1,009.6 **FY96** $1,021.0
(Note: if funded with Subproject-A, cost will be reduced to $280.7)

Start/Completion: January, 1995 - September, 1995

Project Duration: 0.75 yr.

Geographic Area: Prince William Sound

Contact Person: Howard Ferren, Special Projects Manager
PWSAC, P.O. Box 1110, Cordova, AK 99574
(907) 424-7511

II. Introduction

Following the *Exxon Valdez* oil spill **(EVOS)** Alaska Department of Fish and Game (ADF&G) initiated surveys in Prince William Sound (PWS) and found 106 oiled anadromous streams[1]. The **EVOS** Trustee Council has concluded that pink salmon resources are damaged and non recovering. In addition to salmon resources, other subsistence resources were affected by the spill including many marine invertebrates, birds, and marine mammals. Per capita subsistence harvevst ranged from nearly 200 pounds to over 600 pounds per year[2] pre spill and were reduced 4% to 77% immediately following the spill. Harvest levels in some villages including Chenega Bay and Tatitlek continue at low levels. Not only has subsistence harvesting been disrupted, but traditional cultural patterns of social interaction surrounding the harvesting of local resources have been disrupted[2].

III. Need for Project

Injured and lost resources important to subsistence harvesters must be restored or replaced to provide both the resource base of the community and to re-instill traditional cultural patterns surrounding subsistence harvest and resource use. This project is designed to seek out identifiable depleted salmon stocks important to subsistence users and to restore those stocks through supplementation procedures outlined in subproject 95093-A.

In addition to the primary purpose of replacing and supplementing subsistence resources, the subproject will provide experimentation controls for the geneflow and quantitative genetic analysis components of 95093-A.

IV. Objectives

A. Restore wild stock salmon resources and services in PWS to pre-spill conditions.

B. Maximize fitness (both biologic and economic) of injured wild stocks through application of knowledge of salmon population biology, genetics and disease.

C. Restore salmon stocks in three streams important to subsistence users to replace injured or lost resources and services.

D. Provide experimental control groups for subproject 95093-A which supplements stocks in oil impacted streams.

V. Methods

1. **Inventory and assessment:** This component will have both literature and in-field aspects. Residents of PWS native communities Tatitlek and Chenega, and native residents in Cordova and Valdez, as well as natural resource and anthropological expertise at Chugach Corporation will be contacted for guidance on target streams/stocks. Literature will be reviewed and in-field observations conducted at potential streams. Salmon stocks will be censused and inventoried for phenotype and genotype. Samples will be taken for pathogen and parasite assessment. Facilities will be assessed for water regime and possible modifications to suit supplementation requirements.

2. **Implementation:** Implementation will have several phases including stream survey, substrate sampling, brood stock collection and sampling, eggtake, egg transport to supplementation facility, incubation, thermal marking, return of fry to natal stream for net pen rearing and acclimation. All necessary permitting including hatchery permit alterations (PAR), fry transport permits (FTP), Alaska Coastal Consistency Review, DNR Tideland's lease and bonding, Army Corps anchoring permit, and U.S. Coast Guard anchoring permit must be obtained.

3. **Evaluation:** Supplementation will be evaluated as a tool for restoring and/or replacing lost or damaged subsistence resources. This can be achieved by evaluating supplementation egg to fry survivals, acclimation success by adult homing, adult survivals for seeding the habitat, and pattern changes in subsistence use of the resource.

   Stocks selected for subsistence restoration will also provide the control experiments required to evaluate supplementation within oil impacted streams (subproject **95093-A**). The experimental control process is to include:

   a. Straying/gene flow field experiment: (SFOS Division of Fisheries)
   This research is modelled on earlier work on pink salmon at Auke Creek in Juneau by A.J. Gharrett and colleagues. Straying may be estimated by observing physically marked or tagged salmon; however, straying is only one component of gene flow--strays may well not breed successfully to contribute genetically. Our proposed protocol is to screen male returning salmon at a weir, allowing about 20%, those bearing a relatively rare presumably neutral gene, to spawn naturally. This procedure genetically

tags the stock; applied with different marker genes to two stocks in the same region, a precise estimate of actual gene flow can be obtained by simple monitoring of the stocks over several generations. Integrates with Project Proposal 95076 by Wertheimer, et al.

b. Fitness phenotype laboratory experiment: quantitative genetic analysis of life history and fitness traits. (SFOS Division of Fisheries)
This research is developed from earlier work on pink salmon at Auke Creek and at Gastineau Hatchery by W.W. Smoker, P.A. Crandell, and colleagues. Gametes sampled from known parents in stocks under restoration will be taken to the incubation laboratory at Juneau and observed under a standard quantitative genetic experimental design. Analysis of observations of fitness-related developmental traits (rates of development, salinity tolerance, etc.) and developmental stability (fluctuating asymmetry of meristic and morphologic traits) will provide estimates of genetic parameters, and from observations of hybrid families, direct estimates of the fitness effects of gene introgression.

c. Analysis of fitness effects on natural spawning stocks of interactions with cultured fish based on observed PWS data. (SFOS Division of Fisheries)
Recent biometrical simulations of hypothetical salmon production systems, modelled on PWS pink salmon, by AJ Gharrett have demonstrated a relationship between ecological productivity (carrying capacity) and the overall fitness benefit of homing or straying. These models will provide a basis for analyzing with biometrical rigor the straying, gene flow, population genetic structure, and quantitative fitness variation data collected by other components of this integrated project.

Requisite to a thorough evaluation of the supplementation process, fish incubated at facilities must be marked for later identification. Therefore, additional methods employed in this subproject must include:

a. Coded micro wire tagging: Refer to Project Proposal 95137, 95320: Stock ID and Monitoring Studies.

b. Thermal manipulation of otolith microstructure Contained in Project Proposal 95320C, Otolith thermal mass marking.

4. **Logistics:** Logistical support will be provided by the Native Village of Eyak Tribal Council and include locally owned vessels with local resident crews and technical teams. Inventories, sampling, egg takes, pen rearing acclimation, and other activities will involve the logistical support services.

One vessel and team will be required for habitat assessment, salmon stock inventory, fish sampling and eggtake. Three vessels and crews will be required during fry pen rearing and acclimation. A detailed cooperative agreement established between PWSAC, Native Village of Eyak Tribal Council, and UAF-SFOS establishes the collaborative responsibilities.

VI. Schedule for FY95

NOTE: The schedule is presented for FY95. Specific objectives and activities are intended to occur annually to encompass two (2) life cycles for both odd year and even year pink salmon.

Activity	Begin	End
Evaluate hatchery capabilities		
Analyze facilities' water temperature and water flows	1/95	2/95
Review incubation and facility floor plans	2/95	3/95
Compute species/stock limitations	2/95	3/95
Report on recommendations	3/95	4/95
Literature and subsistence user review		
Review literature	1/95	2/95
Obtain guidence from subsistence users	1/95	3/95
Identify injured stocks for supplementation activities	2/95	3/95
NEPA compliance		
Complete NEPA requirements	2/95	4/95
Develop and deploy logistical support		
Contract vessels and crews	5/95	5/95
Contract technicians	5/95	6/95
Train field crews	5/95	6/95
Inventory and assessment		
Stock surveys	7/95	10/95
Census/phenotypes	7/95	10/95
Take fish samples	7/95	10/95
Analyze for pathogens/parasites	8/95	9/95
Assess stream conditions		
Collect stream gravel samples	6/95	7/95
Analyze samples	6/95	8/95
Direct restoration		
Collect eggs from streams	8/95	9/95
Incubate embryos	9/95	12/95
CWT/otolith mark embryos	9/95	10/95
Pen rear, acclimate & release fry	*1996*	
Recover marks/tags	*1997*	
Evaluate & revise plan	*1997*	

Activity	Begin	End
Geneflow field experiment		
Establish genetic tag	7/95	9/95
Sample returns	*1997*	
Analyze gene flow	*1997*	
Report	*1998*	
Quantitative genetic analysis of fitness traits		
Sample gametes in field	7/95	10/95
Incubate embryos in lab and gather data	10/95	*1996*
Analyze	*1996*	
Report	*1997*	
Model fitness effects of genetic interactions; develop simulation models for:		
Gene flow and drift	2/95	11/95
Single locus selection	7/95	*1996*
Quantitative/fitness trait	12/95	*1997*
population dynamics	*1996*	*1997*
Report	9/95	10/95

VII. Technical support

Technical support will include the services of:

- PWSAC planning, project management and fish culture staff
- ADF&G biologists and technicians
- University of Alaska geneticists
- ADF&G pathologist
- permitting agencies including ADF&G, Department of Army, Corps of Engineers, Department of Natural Resources
- ADF&G otolith mark analysis lab

VIII. Location

This project will take place in Prince William Sound. Specific streams identified or supported by subsistence users will be selected as sites for supplementation.

IX. Project Implementation

PWSAC will implement the project in conjunction with the Native Village of Eyak Tribal Council, University of Alaska, School of Fisheries and Ocean Sciences, and with ADF&G as the lead agency.

X. Coordination of Integrated Research Effort

PWSAC will be responsible for coordinating activities under this proposal including research, restoration and monitoring. Activities of the subsistence restoration subproject will be integrated with previously funded and proposed genetic investigations, stream analyses, stock identification and monitoring studies, and otolith marking.

XI. Public Process

PWSAC is a regional association having representatives from various user groups, communities and businesses seated as the Board of Directors. The Board has authorized this subproject and suite of salmon projects under the title of Restoration of PWS Natural Spawning Stock Salmon Resources and Services Overview: An Integrated and Collaborative Approach. The project has had wide exposure and endorsement throughout PWS. In addition, **NEPA** requirements will be met prior to stream supplementation activities.

XII. Personnel Qualifications

PWSAC

B. Roys
President, CEO
B.S. Wildlife Management, University of Massachusetts
Fisheries biology, fisheries management, organizational management.

H.J. Ferren
Special Project Manager, Planner
M.S. Biological Oceanography, University of Alaska
Corporate strategic and tactical planning, regional salmon planning, team facilitation and project management.

Eric Prestegard
Fisheries Manager
A.A. Fisheries
Fish culture, fisheries research, quality control, fisheries management.

C. Kerns
Principal Fish Culturist
M.S. Fisheries Biology, Michigan State University
Chairman Alaska Fisheries Council (1979-83); President American Fisheries Society (1983-84); Certified Fisheries Scientist; Former Associate Professor, University of Alaska; Management in fish nutrition research.

Native Village of Eyak Tribal Council

B. Henrichs
President
Native; fisherman; vessel coordination and logistics.

D. Daisy
B.S. Fisheries, University of Massachusetts
Fisheries Rehabilitation Program Manager (ADF&G); Consultant in fisheries development and aquaculture.

University of Alaska, SFOS

W.W. Smoker
Professor of Fisheries, SFOS.
PhD Fisheries, Oregon State Univ.
Research in salmon ocean ranching, quantitative genetics of Pacific salmon.

A.J. Gharrett
Professor of Genetics, SFOS
PhD Genetics, Oregon State Univ
Research on molecular genetics, population genetics of Pacific salmon.
Recognized expert on population genetics of Pacific salmon, Genetic Stock Identification, genetic tagging

Patricia A. Crandell
Postdoctoral Fellow and Research Associate, SFOS
PhD Aquaculture Genetics, Biometrics Univ. of Calif Davis
Research on quantitative genetics of pink salmon, ploidy manipulation in Pacific salmon
Expertise in experimental design and statistical analysis.

Andrew Gray
Research Associate, SFOS
MS Genetics, Washington State University
Molecular genetics techniques, Electrophoretic analysis of allozymes, DNA analysis

XIII. Budget

Subproject 95093-C

	PWSAC	EYAK	UAF	ADF&G
100 Personnel	$80.5	$129.3	$184.5	$0.0
200 Travel	$19.1	$12.6	$7.2	$0.0
300 Contractual Services	$0.0	$61.5	$16.0	$75.0
Administration	$16.0	$32.4	$111.9	$3.8
400 Commodities	$7.0	$4.3	$40.0	$0.0
500 Equipment/capital	$0.0	$8.5	$200.0	$0.0
PROJECT BUDGETS	**$122.6**	**$248.6**	**$559.6**	**$78.8**
TOTAL PROJECT BUDGET	**$1,009.6**			

NOTE: If Subproject-A is funded, then cost of Subproject-C is reduced to $280,750 by elimination of activities and cost duplications. Conversely, if C is funded, then costs of Subproject-A are reduced to a similar amount. Total cost if both A and C are funded is $1,290,229. Funded separately, the projects will cost in excess of $2,000,000.

References

1. Alaska Department of Fish and Game, *Exxon Valdez* Oil Spill Response Operations Report - Habitat Division 1989-1992. June 1992.

2. Draft *Exxon Valdez* Oil Spill Restoration Plan. *Exxon Valdez* Oil Spill Trustee Council. 1993.

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EXXON VALDEZ TRUSTEE COUNCIL
1995 Federal Fiscal Year Project Budget
October 1, 1994 - September 30, 1995

Project Description: **Restoration of 3 salmon stock important to subsistence** targets natural spawning stock restoration through a program of stock inventory, supplementation and genetics investigtion. The project is designed to replace salmon resources lost to subsistence users as a result of the Exxon Valdez oil spill. The project will focus on streams important to subsistence users; it will also provide the experimental control for 95093-A if that project is funded.

Budget catagory	1994 Project No. Authorized FFY 94	94 Report/ 95 Interim* FFY 95	Remaining Cost** FFY 95	Total FFY 95	FFY 96	Comments
Personnel	$0.0	$0.0	$346.4	$346.4	$361.0	- primary cost assoc with genetics research
Travel	$0.0	$0.0	$38.8	$38.8	$38.8	- can be reduced by shared air charters
Contractual	$0.0	$0.0	$152.5	$152.5	$247.0	- increases in 1996 with added vessels
Commodities	$0.0	$0.0	$32.3	$32.3	$36.3	- assoc. with science, field work & vessels
Equipment	$0.0	$0.0	$108.5	$108.5	$69.0	- 1995 experiments eqpmt; 1996 net pens
Capital Outlay	$0.0	$0.0	$0.0	$0.0	$0.0	
Subtotal	$0.0	$0.0	$678.5	$678.5	$752.1	
General Administration	$0.0	$0.0	$127.1	$127.1	$133.5	- PWSAC/EYAK @ 15%; UAF @ 25%
Project Total	$0.0	$0.0	$805.6	$805.6	$885.6	
	**NOTE: If 95093-C is funded jointly with 95093-A, cost for -C will reduce to $251,000					Note: feasibility study and research projected to occur over two life cycles of both even and odd year cycle pink salmon. One life cycle will provide much towards understanding injured stock supplementation; lethal trait inheretibility, geneflow and straying. Subproject 95093-C will provide both the experiment control & subsistence restoration.
Full-time Equiv. (FTE)	0.0	0.0	0.0	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
PWSAC proj leader (biologist,manager)			9.0	$46.9
PWSAC fish culturist			3.0	$13.2
PWSAC fish tech (2 @ 1mm ea)			2.0	$4.8
Eyak logistic manager, bio. coordinator, clerk			9.0	$97.0
UAF-SFOS Princ inveti.; subproj investi; researh assoc. seasonals (10); grad research assist.			60.0	$184.5
Personnel Total	0.0	$0.0	83.0	$346.4

NEPA Cost: $75.0
* Oct 1, 1994 - Dec 31, 1994
** Jan 1, 1995 - Sep 30, 1995

1995

Project Number: 95093-C
Project Title: Restoration of 3 Salmon Stocks Important to Subsistence
Agency: Prince William Sound Aquaculture Corporation

Travel	Rept/Intrm	Remaining
ANCH/CDV : 4 RT @ $300 + 3 day per diem	$0.0	$3.6
Field travel: including supplementation site visit to review facility to accommodate injured stock (6hrx$250/hr)	$0.0	$1.5
- remote travel to selected oiled streams for inventory and assessment (4 RT @ $250/hr x 3hr)	$0.0	$3.0
- air transport gravel/fish samples (3 RTx $250/hr x 3 hr);	$0.0	$2.3
- transport fish techs and eggs to supplementation facility (12 RTx $250/hr x 3 hr);	$0.0	$9.0
- UAF researcher travel	$0.0	$7.2
- project leader remote travel (2RT x $250/hr x 6hr)	$0.0	$3.0
- logistics manager remote travel (2RT x $250/hr x 6h)		$3.0
- biological coordinator remote travel (6RT x $250 x 4hr)		$6.0
Travel Total	$0.0	$38.6
Contractual		
Eyak: vessel contract @ $1,500/day x 41 days	$0.0	$61.5
UAF-SFOS: contract for laboratory/facilities and use	$0.0	$16.0
ADF&G: NEPA compliance(3 EAs @ $25,000)	$0.0	$75.0
Contractual Total	$0.0	$152.5

Commodities:	Rept/Intrm	Remaining
PWSAC: field supplies including sample containers, gloves, note books, nets/seines, sampling tools, tags, electro shocker.	$0.0	$7.0
EYAK: office supplies; vessel commodities for crew ($15/person/day).	$0.0	$4.3
UAF-SFOS: field and laboratory supplies.	$0.0	$21.0
Commodities Total	$0.0	$32.3
Equipment:		
EYAK: office equipment (computer, printer, copier)	$0.0	$8.5
UAF-SFOS: electrophoresis equipment and field camp materials.	$0.0	$100.0
Equipment Total	$0.0	$108.5

Project Number: 95093-C
Project Title: Restoration of 3 Salmon Stocks Important to Subsistence
Agency: Prince William Sound Aquaculture Corporation

Sound Waste Management Plan

Project Number:	95115
Restoration Category:	General Restoration (new)
Proposed By:	Prince William Sound Economic Development Council
Lead Trustee Agency:	ADEC
Cost FY 95:	$284,500
Cost FY 96:	$ 15,600 to complete Phase I. Additional funds may be needed for Phase II, see below for explanation.
Total Cost:	Unknown
Duration:	Unknown
Geographic Area:	Prince William Sound
Injured Resource/Service:	Intertidal and subtidal organisms, harlequin ducks, black oystercatchers, sea otters, harbor seals, and other seabirds, shorebirds and marine mammals. The services most likely to benefit are subsistence and recreation, both of which are affected by the visual recognition of pollution.

INTRODUCTION and NEED FOR THE PROJECT

Abstract: The Sound Waste Management Plan (SWMP) is a comprehensive plan to identify and remove the major sources of marine pollution and solid waste in Prince William Sound that may be affecting recovery of resources and services injured by the *Exxon Valdez* Oil Spill. The first phase of the plan will identify the major sources of marine pollution and solid waste, identify their significance, and recommend solutions to reduce the effects that can be implemented by municipalities, state and federal governments, private industry, or trustee agencies. The following phases of the plan will be to implement these solutions. Only the first phase is proposed for FY 1995, and will be implemented using funds from the Alaska Department of Commerce and Economic Development as well as from *Exxon Valdez* Trustee Council.

In total, the plan will use funds from a variety of sources to effect a unified regional effort to permanently reduce the incremental damage being done to the environment of Prince William Sound from marine pollution. In this way, it will reduce stresses on recovering resources and services and protect their habitat.

Background: Despite the panoply of state and federal laws that govern the discharge of pollutants into the marine environment, there remain a number of important waste streams that still foul the environment of Prince William Sound. Complete restoration from the oil spill requires permanent protection from on-going chronic pollution sources that may be degrading the quality of marine habitat for injured resource and services, or may be stressing populations or sub-populations of resources and services.

In many cases, there is currently no easy or no feasible method of meeting state and federal laws designed to protect the Sound's environment. The communities of Prince William Sound, the Coast Guard, EPA, and ADEC are working on parts of these problems, but there is no regional approach. Currently, the lack of a coordinated, comprehensive approach may preclude effective, regional solutions, and may result in some important, regional problems not being addressed. The lack of a region approach may also preclude cost-effective solutions that are beyond the capacity of individual agencies or communities. As a result, there may be increased stress on the resources and services injured by the spill, especially on local populations important for communities, recreation, and subsistence use.

The major waste types that appear to have the greatest potential to affect injured resources and services are below.

- **Waste Oil.** Engine oil and bilge water are sources of waste oil, much of which is discharged into the waters of Prince William Sound.

  Engine Oil. Vessels and communities in Prince William Sound generate large quantities of used motor oil and other lubricants. 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 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.* Most areas of the country have more, or more convenient facilities than does the spill area.

  Cordova, Valdez, and Whittier all have at least one waste oil burner. The burners take waste oil and provide heat for community buildings or electricity for the municipality. In some cases, more capacity may be needed. These facilities have made it feasible for vessels and engine owners to conveniently dispose in a safe and non-polluting manner. For example, there are three waste-oil burners in Cordova, which is the site of a large fishing fleet. One burners, operated by Cordova Electric Cooperative, collected and burned 21,000 gallons of waste oil last year and used the heat for two buildings. Homer, though outside of Prince William Sound, typically serves 850 boats in the harbor at any one time, burned approximately 6,000 gallons per year of waste oil to heat two buildings.

  Tatitlek and Chenega lack waste oil burners. These two communities are currently installing docks facilities for handling more boat traffic. The increased activity is likely to increase the potential for inappropriate disposal of waste oil near the communities. For that reason, federal law requires that public docks with significant traffic have solid waste

and waste oil collection — a requirement that is frequently not met in small, rural communities because of the difficulty in disposing of the collected material.

Bilge Water. Bilge water includes grease and oil from engines and machinery. There is currently no feasible and convenient method in the Sound for fishing, commercial, or recreational vessels to legally dispose of bilge water. There is no community with facilities to conveniently accept bilge water, and as a result, much is probably dumped into Prince William Sound. Much of it is probably dumped in or near the small boat harbors.

- **Stormwater Runoff.** Stormwater runoff contains grease and oil from city streets, chemicals from laws and buildings, and other polluting residues. Cordova, Valdez, and Whittier all have stormwater systems that discharge directly into the bay, in some cases into habitats such as the Valdez Duck Flats that are essential for resources injured by the spill.

- **Oily Waste.** Oily waste is the residue of materials that contain oil. Oil filters, absorbent pads, and cleaning materials are examples of oily waste. In most communities there is no alternative but to place oily waste in the landfill. Valdez is working to acquire a crusher to press the oil out of old filters and material. This will reduce the amount of oil in other waste materials, but in most communities, the waste becomes part of the landfill. None of the landfills or dumps in Prince William Sound have an impermeable membrane, and some portions of the oil migrates to water sources.

- **Sewage.** Sources of sewage include the communities, vessels, and land-based and floating remote lodges. There is no feasible or convenient method for the fishing, commercial, or recreational vessels to legally dispose of the sewage. While some of the large vessels have sewage disposal systems on board, most dump the waste overboard with minimal if any treatment. There have been reports that some remote camps are out of compliance and causing local habitat problems due to improper sewage disposal. In some locations, the amount of sewage may be safely dispersed without significant effect on the local environment. In other locations, there is potential for significant effect.

- **Solid Waste.** Currently each community in Prince William Sound is out of compliance with federal regulations as it relates to permitting of waste sites. Improper solid waste disposal has the potential to affect water sources and upland habitat used by injured resources. Blowing garbage is a problem in the two communities without a sanitary landfill (Chenega and Tatitlek). Cordova's landfill currently includes diked off tideland areas and the lower portion of the landfill is inundated by the tide. As a result, landfill leachate may contaminate Orca Inlet. In addition, leachate from Valdez's landfill probably reaches Port Valdez.

- **Household Hazardous Waste.** The three incorporated communities have methods of feasibly disposing of household hazardous waste, but collection is infrequent. The two unincorporated communities do not collect household hazardous waste. As a result, much hazardous waste is probably improperly dumped.

- **Fish Wastes.** Sources of fish waste include, shore-based processors, floating processors, and sports-fish cleaning stations (usually in small boat harbors).

  Shore-based Processors. There appears to be problems with accumulation of offal from fish processors in Valdez and Cordova. The accumulation of many year's of processing wastes in the shallow inlet off Cordova appears to have created an anaerobic zone on the inlet's floor — unusable habitat to the fish, subtidal, and marine mammal resources of the area. There have been recent incidents in Valdez where an unusual stench may be traceable to an accumulation of offal near the processors. In both cases, there are activities by the cities, state, EPA, and fish processors to solve the problems, but no solution is as yet apparent.

  Floating Processors. In some cases, there may be similar problems with floating processors accumulating wastes in one location. In other cases, the floating processors may distribute their fish wastes without significant harm to the local environment.

  Sport-fish Cleaning Stations. The largest sports fishery in Prince William Sound is based out of Valdez, though significant fisheries exists from Cordova and Whittier. In each case, cleaning occurs at sports fish stations in the small boat harbor, and the wastes concentrate in the boat harbor beneath the station. This can overburden waters of the small boat harbor and reduce water quality below federal or state minimums.

Two examples show the potential effects of these problems. The first, Valdez Duck Flats, is adjacent to the Valdez Small-boat Harbor. It is an Area Meriting Special Attention in the Valdez Coastal Management Plan because of its important habitat value. It includes 450 acres of mud flats and 460 acres of saltwater marsh. It provides habitat for rearing salmon and has been recognized by state and federal agencies as providing essential waterfowl habitat for species injured by the spill. The habitat of the Duck Flats may be degraded by the storm water runoff which empties into the area, or by discharges from boats outside the harbor, landfill contamination flowing down Valdez Creek, or sewage disposal in the Port.

Orca Inlet, outside Cordova has the largest pupping concentration of sea otters in Prince William Sound, and is also important for sport fishing, hunting, and is seasonally used by large concentrations of seabirds and waterfowl, including many resources injured by the spill. It is a part of the largest contiguous wetland in the western hemisphere which, during migrations, hosts the largest concentration of shorebirds in the world. The Cordova waterfront hosts most of the problems referenced above. The shoreline includes the solid-waste landfill, which is built in part on tidelands and is inundated by the tide twice each day; storm-water and sewer outfalls, and outfalls for fish-processing offal which has created an anaerobic zone on the inlet floor.

The table below summarizes problems in the communities of Prince William Sound.

Key
▣ = Some of waste stream likely enters marine waters.
ff = Facilities or community program available (though not necessarily adequate).

Waste Stream:	Cordova	Valdez	Tatitlek	Chenega	Whittier
Waste Oil					
Engine Oil	▣ ff	▣ ff	▣	▣	▣ ff
Bilge Water	▣	▣	▣	▣	▣
Stormwater Runoff	▣	▣			▣
Oily Waste	▣	▣	▣	▣	▣
Sewage					
Community	ff	ff			ff
Vessels	▣	▣	▣	▣	▣
Solid Waste	▣ ff	▣ ff	▣ ff	▣ ff	ff
Household Hazardous Waste	▣ ff	▣ ff	▣	▣	▣
Fish Wastes					
Processors	▣	▣			▣
Sport-fish cleaning	▣	▣			

The problems referenced above may be affecting resources and services injured by the spill, including disruption of important habitat. Any decrease in local pollution would have the effect of decreasing the stress on injured resources and services that rely on clean water. Those resources and services likely to benefit the most are those that feed in the intertidal or near-shore waters in the vicinity of community waterfronts and small boat harbors. These resources most likely to benefit include harlequin ducks, black oystercatchers, sea otters, harbor seals, and other seabirds, shorebirds and marine mammals. The services most likely to benefit are subsistence and recreation, both of which are affected by the visual recognition of pollution.

Project Description. A three phase approach is proposed. This project, however, includes funding for only the first phase. The project will be managed by the Prince William Sound Economic Development Council in conjunction with the Alaska Department of Environmental Conservation.

In continuing the efforts of the Prince William Sound Economic Development Commission, costs for the project are defrayed by shared transportation, teleconference and meeting costs from each participating community and organization. The regional approach resulted in the

development of this project, and is the overall approach of each phase of the project.

With each community independently combating some of the problems of marine pollution, by coming together as a region, ideas are shared and discussed in a manner that leads to more efficient and cost-effective solutions which is the theme of the proposal. The success of this regional approach by the regional committee is the impetus for this project and will be maintained.

- Phase I will use a request for proposals to solicit a contractor to undertake a comprehensive review of pollution sources, their significance, and provide alternative cost-effective solutions.

- Phase II will handle required ADEC/EPA permitting to implement solutions.

- Phase III is the implementation of the Sound Waste Management Plan — implementing permanent solutions to the existing chronic problems. These solutions may take the form of a construction, such as a regional solid waste facility or facilities to accommodate bilge water, or they may take the form of programs to prevent pollution such as increased recycling.

Contributions from Other Funding Sources. The funding contributed by the Trustee Council for Phase I would be coordinated with funding proposed by the City of Valdez, and that contributed by the Alaska Department of Transportation and Public Facilities. In addition, many of the solutions proposed as a result of Phase I, are likely to be funded all or in part by municipalities, villages, private industry, the federal government, and the State of Alaska. Some solutions may be appropriate for funding from the civil settlement.

The proposed budget for the City of Valdez for calendar year 1995 includes $100,000 to investigate long-term solutions to the solid waste problems in Valdez. The questions that study will investigate include some of those to be investigated by this proposal. Valdez will not act upon its budget proposal before Trustee Council action is expected. However, if passed, the Valdez appropriation would be coordinated by Bill Wilcox, Valdez City Engineer and Director of Public Works. Mr. Wilcox is also on Prince William Sound Economic Development Commission's Solid Waste Subcommittee that would oversee this project. Thus, the City's proposed appropriation is another financial contribution to this project.

The Alaska Department of Transportation and Public Facilities has given a contribution for a related project. The department has given $100,000 grant to each of Cordova and Valdez to implement a junk car and scrap metal recycling project. Valdez has an inventory of 1,500 old cars, and Cordova has 500. The grants would enable these communities to crush and recycle these cars and other scrap metals. This would eliminate waste stream from the landfills (and because of oil and other toxics associated with the cars, it may have some effect on eliminating those sources from entering marine waters). The two grants were coordinated by the Prince William Sound Economic Development Commission, and will be implemented so that the crusher can be used regionally — for materials from Chenega, Tatitlek, and if feasible, Whittier.

PROJECT DESIGN

A. Objectives. The development of the Sound Waste Management Plan originated with Prince William Sound Economic Development Council's regional Solid Waste Management Committee.

The following outlines the objectives to be accomplished as part of Phase I:

1. Identifying options.

a. Use existing information and where necessary gather new information to identify the major sources of marine pollution and solid waste, and evaluate which waste streams are priority for reduction.

b. Analyze waste management reduction, processing, transportation, and disposal alternatives appropriate for Prince William Sound. Information for some or all alternatives should include regulatory requirements, site information, cost estimates, transportation methods, and funding sources.

c. Recommend solutions to reduce the effects that can be implemented by municipalities, state and federal governments, private industry, or trustee agencies. Many of these may involve regional coalitions of groups.

2. *Community choice.* This project is not solely technical; rather, communities and agencies must implement the technical solutions. For that reason, the project objectives include establishing a public participation program to understand and address community concerns and needs. The public participation needs not involve public meeting or other mass participation mechanisms. However, it should ensure that communities are involved, and understand the problems and possible solutions in order to build consensus for actions to reduce marine pollution and solid waste that will restore Prince William Sound. Accomplishing this objective requires communities and agencies to choose which options to implement.

B. Methods

1. *Community Participation Component.* As a regional project, local input and coordination is crucial to the long-term success of the SWMP project by creating local ownership. Agreeing on and implementing effective solutions to waste management problems requires the participation of the communities that will implement them. A comprehensive, coordinated, regional approach requires participation by all communities in Prince William Sound. This proposal was developed and intended to be coordinated by Prince William Sound Economic Development Council's Solid Waste Management Committee with representation from all of the Sound's communities. The project will be completed in cooperation with ADEC.

a. DEC will do the financial administration of the contract that is the major part of Phase I.
b. Prince William Sound Economic Development Council's Solid Waste Management Committee with participation from each of the Prince William Sound communities, DEC, and possibly with EPA and the US Coast Guard will manage the contract. This participation is important for the results of the project — that the recommended solutions will be agreed to and implemented by the appropriate communities and regulatory agencies.

2. *Technical Component for Phase I.* A Request for Proposals will solicit the most qualified firm to accomplish the objectives of Phase I.

C. Schedule (FY 95 - Plan of Work)

November 15, 1994	Begin writing RFP
November 30, 1994	Advertise RFP
February 1, 1995	Award Contract
August 1, 1995	Draft Report to the PWS Economic Development Council and ADEC
September 1, 1995	Final Report

D. Technical Support

All technical support will be provided by the Prince William Sound Economic Development Council's regional Solid Waste Management Committee, and by the Alaska Department of Environmental Conservation.

E. Location

Prince William Sound

PROJECT IMPLEMENTATION

For the most part, solutions to the identified problems will be implemented by communities and local groups. They must be the major part of the process to identify and choose these solutions. To maintain the direct link from development and implementation of the SWMP, Prince William Sound Economic Development Council's regional Solid Waste Management Committee in cooperation with DEC will implement this regional project in cooperation with ADEC.

The Contractor will be selected by competitive solicitation. PWS Economic Development Council will manage the contract under agreement to ADEC. The Economic Development Council is an Alaska Regional Development Organization (ARDOR) which under AS 36.30.850 may receive funds from the state without competitive solicitation. (The contractor will be selected using normal, State of Alaska competitive procedures.)

PUBLIC PROCESS

This project will be administered, in cooperation with DEC, by representatives of the affected communities. The Prince William Sound Economic Development Council includes representatives of each community, and industry representatives including the fishing, tourism, and petroleum industries. The process will continue with public review at local city council and village council meetings for comment as part of the SWMP. An integral part of the SWMP is community education.

COORDINATION OF INTEGRATED RESEARCH EFFORT

This project is not research, and integration with other Trustee research activities is unnecessary.

FY 95 BUDGET ($K)

Personnel	$12.8
Travel	6.0
Contractual	245.6
Commodities	1.0
Equipment	0.0
Capital Outlay	0.0
Subtotal	$265.4
Gen. Admin.	19.1
Total	$284.5

1995 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1994 - September 30, 1995

Project Description: This project will explore various options for regional management of waste oil, associated toxics and solid waste. This project is intended to reduce the pollutants introduced into the environment injured by the *Exxon Valdez* oil spill so that natural recovery may proceed as quickly as possible.

Budget Category:	1994 Project No. . . . . Authorized FFY 94	'94 Report/ '95 Interim* FFY 95	Remaining Cost** FFY 95	Total FFY 95	FFY 96	Comment
						FFY 96 expenses to complete Phase I.
Personnel	$0.0	$0.0	$12.8	$12.8		$7.0
Travel	$0.0	$0.0	$6.0	$6.0		$3.8
Contractual	$0.0	$0.0	$245.6	$245.6		$3.0
Commodities	$0.0	$0.0	$1.0	$1.0		$0.5
Equipment	$0.0	$0.0	$0.0	$0.0		$0.0
Capital Outlay	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Subtotal	$0.0	$0.0	$265.4	$265.4	$0.0	$14.3
General Administration	$0.0	$0.0	$19.1	$19.1	$0.0	$1.3
Project Total	$0.0	$0.0	$284.5	$284.5	TBD	$15.6
Full-time Equivalents (FTE)	0.0	0.0	0.2	0.2		0.1
	Dollar amounts are shown in thousands of dollars.					

Budget Year Proposed Personnel: Position Description	Reprt/Intrm Months	Reprt/Intrm Cost	Remaining Months	Remaining Cost
Restoration Specialist (R-23)	0.0	$0.0	1.0	$6.9
Restoration Specialist	0.0	$0.0	1.0	$5.9
Personnel Total	0.0	$0.0	2.0	$12.8

FFY 96 activities and costs for Phase II (primarily permitting and preparation for implementation in Phase III) can only be determined following substantial completion of Phase I which will identify regional and community solutions for marine pollution affecting Prince William Sound.

NEPA Cost: $0.0

*Oct 1, 1994 - Dec 31, 1994
**Jan 1, 1995 - Sep 30, 1995

Project Number: 95115
Project Title: Sound Waste Management Plan
Agency: AK Dept. of Environmental Conservation

FORM 2A
PROJECT
DETAIL

1995 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1994 - September 30, 1995

		Reprt/Intrm	Remaining
Travel:			
Juneau to Anchorage and PWS ($450/trip + 2 days per diem @ $150/day x 8 trips)		$0.0	$6.0
	Travel Total	$0.0	$6.0
Contractual:			
Long distance phone and fax		$0.0	$1.0
Mail and courier		$0.0	$0.8
Copying and printing		$0.0	$2.0
Freight and cartage		$0.0	$0.2
Plane/helicopter charter to Prince William Sound communities		$0.0	$2.0
Film processing		$0.0	$0.1
Contract for consultant to develop regional waste Management Plan		$0.0	$210.0
RSA with Prince William Sound Development Council to manage contract through March 1996		$0.0	$29.5
Project Manager 320 hours @ $47/hr	$15.0		
Travel	$12.5		
Teleconference fees	$2.0		
	Contractual Total	$0.0	$245.6

Project Number: 95115
Project Title: Sound Waste Management Plan
Agency: AK Dept. of Environmental Conservation

FORM 2B
PROJECT
DETAIL

1995 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1994 - September 30, 1995

Commodities:	Reprt/Intrm	Remaining
Office supplies	$0.0	$0.6
Computer supplies	$0.0	$0.4
Commodities Total	$0.0	$1.0
Equipment:		
Equipment Total	$0.0	$0.0

07/14/93

1995

Printed: 9/28/94 9:15 AM

Project Number: 95115
Project Title: Sound Waste Management Plan
Agency: AK Dept. of Environmental Conservation

FORM 2B
PROJECT
DETAIL

Project # 95124A (revised) 9/15

Project Title: Tatitlek Mariculture Development Project

Project Leader: Gary Kompkoff

Lead Agency: Tatitlek IRA Council

Cost of Project: FY 95 - $109.5K; FY 96 - $122.0K; FY 97 - $156.1

Project Start-up/Completion Dates: October, 1994 to September, 1997

Project Duration: 3 years

Geographic Area: Tatitlek, Prince William Sound

Contact Person: David Daisy, 3936 Westwood Drive, Anchorage, AK 99517; phone 243-8544, fax 243-1183

Introduction

This project is intended to provide a long term source of subsistence food for the residents of Tatitlek. Although oysters are not indigenous to Alaska and cannot reproduce in these cold waters, they grow well here under cultivation and have become an accepted subsistence food. There are several advantages to developing cultivated oyster operations for subsistence use. First, the operation can be located close to the village, making collecting this food a relatively easy operation. Second, the level of production can be adjusted to any size needed. Third, because it can be well located and adjusted to produce any volume needed, an oyster culture operation is an ideal mechanism for taking subsistence harvest pressure off of injured resources and give them a chance to recover. Fourth, an oyster culture operation has minimal impact on the environment.

The project has already gone through feasibility testing. This funding is being sought to help the mariculture project through the development stage and achieve self sufficiency. Self sufficiency will be achieved by using a portion of the production for cost recovery. The development stage will continue through the next three years and will consist of continued training of local mariculture workers, cost of operations and setting up the project management structure in the village.

Project Need

This project is needed to replace lost subsistence resources and provide the village with a means to develop a local bivalve resource in a manner that provides some level of protection against future man-made disasters such as EVOS. The oil spill amply

demonstrated how vulnerable the local marine resource is to disasters such as the oil spill. As well as being an efficient way of utilizing the local marine environment, the mariculture techniques that will be utilized in this project will allow steps to be taken to protect the shellfish that are under culture from the effects of disasters such as EVOS.

Project Design

Objectives:

By September 30, 1995 a village management structure will be in place that will provide total oversight and accountability for the mariculture project.
By September 30, 1996 the mariculture will be making a substantial contribution to the subsistence needs of the village.
By September 30, 1997 the Tatitlek Mariculture Project will become self sustaining through cost recovery.

Methods:

The project will continue under the guidance of a mariculture expert. A business development company will be contracted to set up the project management system in the village.

Schedule:

The project will operate year round. Site health certification will take place in early summer, PSP sampling will be on a weekly basis, product will be available for subsistence use and sale year round, activity reports will be submitted quarterly.

Technical Support:

Mariculture expert, lab analysis for certification and PSP samples.

Location:

The project will take place near the village of Tatitlek.

Project Implementation

The Tatitlek IRA Council will be primarily responsible for the project with assistance from the Chugach Regional Resources Commission (CRRC).

Coordination of Integrated Research

This project is related to project 95124B Tatitlek Mariculture Development - Capital Outlay. However, this project will be able to continue even if 95124B is not funded.

Personnel Qualifications

The Tatitlek IRA Council has been involved with the mariculture project since it began in 1991. CRRC has been providing administrative assistance. Jeff Hetrick of Alaska Aquafarms, Inc. will continue to provide training and technical guidance. Mr. Hetrick has extensive experience in mariculture development in Alaska.

Budget

This project will fund only a portion of the total mariculture budget. The following are those items from the budget that will be funded by this project,

Item	Estimated Cost		
	FY 95	FY 96	FY 97
Personnel	$59.5	$59.5	81.1
Contractual	$15.0	$15.0	$15.0
Commodities	$25.0	$37.5	$50.0
Administration	$10.0	$10.0	$10.0
Total	$ 109.5	$ 122.0	$ 156.1

Project # 95127 (revised)

9/15

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
SUBSISTENCE RESTORATION PROJECT DESCRIPTION

Project Title: Tatitlek Coho Salmon Release Program
Project Leader: Tatitlek Village IRA Council
Lead Agency: Alaska Department of Fish & Game
Cost of Project: FY 95 $39.0
Start-Up/ Completion Dates: January, 1995 - June 1997
Project Duration: Ongoing
Geographic Area: Prince William Sound, Tatitlek Narrows
Contact Person: Gary P. Kompkoff, President
Tatitlek Village IRA Council
P.O. Box 171
Tatitlek, AK. 99677
Phone: (907) 325-2311
Fax: (907) 325-2298

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
RESTORATION PROJECT DESCRIPTION

Project Title: Tatitlek Coho Salmon Release Program

B. INTRODUCTION

Subsistence as well as commercial and sport fisheries were severely disrupted by the oil spill. This project is intended to enhance subsistence resources by permitted releases of coho salmon at designated locations near the Native Village of Tatitlek in order to provide a long term subsistence resource for the residents of Tatitlek. Additionally, the coho salmon made available through this project can serve temporarily as a partial replacement for other subsistence resources, such as harbor seals, which were injured by the spill. Valdez Fisheries Development Corporation presently maintains an enhancement project near the Village of Tatitlek, at Boulder Bay. This project would ensure the continuation of that project.

C. NEED FOR THE PROJECT

Subsistence harvests of all salmon resources have declined considerably since the oil spill, and continue to be affected by it. This project would enhance the recovery of the salmon resources and provide a means for lessening the impacts of continued harvests on other subsistence resources injured by the spill, such as harbor seals.

D. PROJECT DESIGN

I. Objectives:

-provide for the continued production of 50,000 coho salmon smolt at the Solomon Gulch Hatchery in Valdez for transport and release near the Native Village of Tatitlek (Boulder Bay).
-hold and feed coho salmon smolt at net pens at the release site for two weeks prior to release.
-harvest approximately 2,000 coho salmon annually upon their return to imprinting site.

II. Methods:

-Coho salmon will be taken from an ADF&G approved site for incubation and care and raised to smolt stage at the Solomon Gulch Hatchery in Valdez
-Smolt will be transported by boat in designated imprinting sites
-Smolt will be held and fed at net pens for approximately two weeks before releasing to improve survival rates and imprinting.

III. Schedule:

January 1995	Plans reviewed by the NEPA Process, salmon hatcheries
June, 1995	Eggs taken from salmon near the Native Village of Tatitlek
June, 1995	First salmon smolt transported, penned, fed and released
June, 1996	First adult salmon returns of coho salmon
June, 1997	First complete complement of all coho salmon age groups.

Each year smolts will he released in late May or early June.

IV. Technical Support:

Utilization of experience and technical support of Alaska Department of Fish & Fame is necessary for this project. Valdez Fisheries Development Corporation expertise will also be utilized.

V. Location:

The project will occur near the Native Village of Tatitlek. Salmon will be raised to smolt stage at the Solomon Gulch Hatchery at Valdez and released, after imprinting at Boulder Bay.

E. PROJECT IMPLEMENTATION

Valdez Fisheries Development Corporation, who have extensive experience in salmon enhancement activities, will continue their present enhancement of coho salmon near the village. ADF&G expertise will also be utilized.

F. COORDINATION OF INTEGRATED RESEARCH EFFORT

This project is intended to provide funds for the continuance of a salmon enhancement project presently undertaken by Valdez Fisheries Development Corporation and could be accomplished in conjunction with a Sockeye Salmon Release Project being proposed by the Tatitlek Village IRA Council. Developing this subsistence resource will provide a partial replacement for other injured resources, such as harbor seals, until they recover. This supports the efforts of several other proposed projects, such as 95244 (Seal and Sea Otter Cooperative Harvest Assistance) and 95001 (Condition and Health of Harbor Seals).

G. PUBLIC PROCESS

Public meeting in the Native Village of Tatitlek have been held periodically by the Tatitlek Village IRA Council addressing the prioritizing of restoration work.

H. PERSONAL QUALIFICATIONS

Valdez Fisheries Development Corporation personnel leave much experience and expertise in this field, they would work in cooperation with ADF&G personnel in accomplishing the goals of this project.

I. Budget ($K)

ADF&G

Personnel	$2.5
Travel	0.0
Contractual	21.5
Capital Outlay	10.0
SUB-TOTAL	**34.0**
Gen. Administration	3.0
NEPA Compliance	2.0
PROJECT TOTAL	$39.0

Project #95129 (revised)
9/15

A. EXXON VALDEZ OIL SPILL PROJECT DESCRIPTION

1. Project Title: Tatitlek Fish and Game Storage and Processing Center
2. Project Leader: Gary Kompkoff, President, Tatitlek I.R.A. Council
3. Lead Agency: Alaska Department of Fish & Game
4. **Total Cost: $325,000**

   Requesting: $310,000 for processing/freezer building

   or $325,000 for processing/freezer building with smokery
5. Project Start Up/Completion dates: Spring 1994 - 2000
6. Project Duration: Permanent Facility
7. Location: Tatitlek, AK
8. Contact Person: Gary Kompkoff, Tatitlek I.R.A. Council, PO BOX 171 Tatitlek, AK 99677 ph. (907) 325-2311

B. Introduction: Tatitlek proposes to build a fish and game processing/storage/smokery facility. This facility will increase the amount of subsistence food available to the community by making it possible for residents to store a larger number of fish for winter use. The increased ability to store fish for winter use will lessen the need for residents to harvest seals and sea lions.

There are two pieces to this proposed project. The first and most important piece is the subsistence food processing and storage building. Grant funds will be used to design, build, and equip the processing and freezer facility.

The second piece of this proposal, which is independent from the funding for the processing and freezer facility, involves adding a smokery to the facility. The smokery will be used for both subsistence and commercial uses. The commercial use of this facility will cover operation and maintenance costs.

C. Need for the Project: Tatitlek's traditional subsistence harvests have not yet recovered to the pre-oil spill levels. Subsistence activities take more time than they did before the spill because residents have to travel farther and wait longer to find subsistence resources. The residents have also had to use fish to compensate for the decline in shellfish and other subsistence resources. In 1988 54.2% of the subsistence harvest was fish and before the spill in 1989 52.2% of the harvest was fish. But in 1990, 61.3% of Tatitlek's subsistence harvest was fish.

Currently, residents personally own enough freezer space to store subsistence fish only until January or February. An improved processing and freezer facility will allow the residents to store sufficient amounts of fish and other non-marine subsistence resources to last through the entire winter.

The facility will also serve the purpose of lessening the pressure on the injured resources of seals and the scarce and possibly oiled resource of sea lions. This will be possible because the freezer will

make fish and other stored resources available through the winter months when normally villagers harvest less fish and hunt seals and sea lions. According to Alaska Dept. of Fish and Game statistics, the primary time for hunting harbor seals in Tatitlek starts in October when fishing season ends and lasts through April. For sea lions, most are taken between December- February.

D. Project Design:

1. Objectives: The community will be able to clean, process, and store their subsistence food more efficiently than they are currently able.

2. Method: The project will be located in Tatitlek. The Tatitlek IRA council will select an architecture and engineering firm to design the facility this fall. Construction will begin in spring of 1995. A contractor will be selected using a bid type process. The council will hire someone to operate the facility. Once a year a technician from a refrigeration service will come to Tatitlek to check the facility and do preventative maintenance.

The facility design will be complete by early spring 1995 and will be submitted for community review. Construction will begin later that season. Local hire will be encouraged. After construction, the council will oversee the operation of the facility.

The major operations cost for the processing and freezer facility will be electricity, which will be donated by the council. Other operation and maintenance costs will be supported by user fees. The council will hire a staff person to operate, maintain and monitor the facility.

If the smokery portion of this proposal is funded, a marketing consultant will assist the council in selling the smoked salmon. Tatitlek already has the benefit of its Alutiiq Pride brand name, recognizable to Alaskan seafood buyers due to Tatitlek's quality oysters. Salmon Exchange in Valdez has expressed interest in selling smoked fish from Tatitlek to tourists. If the state ferry stops at Tatitlek, a strong possibility as an oil spill response/ferry dock is scheduled to be built there by the Dept. of Transportation in Fall 1994, smoked products can be sold to tourists right in the village.

Technical support will be available from the equipment supplier and the council will contract with a local refrigeration specialist to do

yearly inspections and preventative maintenance as well as repairs as the need occurs.

E. Project Implementation: The village council will manage the construction and operation of the facility. They will hire staff to clean the facility, monitor the freezer temperature and check that sanitation regulations are followed. They will also contract with a refrigeration services specialist for preventative and emergency maintenance.

F. Coordination With Other Proposals: Tatitlek has also requested funds for two remote salmon release projects. This project complements the salmon release projects by making it possible for the residents to process and store the increased number of salmon that may be available to the community

G. Public Process: The idea for this facility was presented at a public meeting held June 15, 1994 in Tatitlek. The council will ask for ideas from the community on what amenities they would use in the facility. These suggestions would go to the designer.

H. Personnel Qualifications: Gary Kompkoff has been president of the Tatitlek Village IRA council for 15 years and works for the council as supervisor of capital projects. He is chair of the board of directors for the North Pacific Rim Housing Authority and is on the board of directors of the Prince William Sound Economic Development Council. He also fishes commercially and for subsistence.

I. Budget: Cost estimates are as follows:

1. Design:	$ 15,000
2. Construction	$ 180,000
3. Equipment	$ 100,000
smokery equipment	$ 15,000
4. Grant Administration	$ 15,000
TOTAL	$325,000

Project #95131 (revised) 9/15

Project Title: Nanwalek/Port Graham/Tatitlek Clam Restoration Project

Project Leader: Chugach Regional Resources Commission

Lead Agency: ADF&G in concert with the Chugach Regional Resources Commission and the village councils in Nanwalek, Port Graham and Tatitlek.

Cost of Project: FY 95 - $208.3; FY 96 - $244.8; FY 97 - $252.7; FY 98 - $261.3; FY 99 - $269.8

Project Start-up/Completion Dates: November, 1994 to October 1999

Project Duration: 5 Years

Geographic Area: Port Graham/Nanwalek area; Tatitlek area

Contact Person: David Daisy, 3936 Westwood Drive, Anchorage, AK 99517; Phone 243-855; Fax 243-1183

Introduction

This project will establish the procedures and begin the process of restoring local clam populations for subsistence use in the Nanwalek/Port Graham area and in the Tatitlek area. Clams were once a major subsistence food in these communities, but the local clam populations have been decreasing to very low levels in recent years and their contribution to the subsistence harvest has been greatly reduced.

There are probably several reasons why local clam populations are currently at low levels. These include changes in current patterns and beach configurations resulting from the 1964 earthquake, increasingly heavy sea otter predation and the Exxon Valdez oil spill.

The oil spill impacted the wild clam populations and their importance as a subsistence food in two ways. First, many clam beds suffered from direct oiling. The impact of the oil on the clam beds in Windy Bay, for instance, destroyed one of the most productive clam beds in the lower Kenai Peninsula. Second, even though some shellfish weren't killed from the oil, they have a tendency to accumulate, concentrate and store the toxic contaminants from non-lethal amounts of oil. This has badly eroded the confidence of the villagers in the healthfulness of the remaining wild clam populations as a subsistence food.

One of the main problems with clam enhancement in Alaska has been the availability of a sufficient supply of seedstock. The Qutekcak Native Tribe of Seward is developing a shellfish hatchery that is currently focusing on providing Pacific oyster seed for the Alaskan aquatic farming industry. The hatchery has also been working to develop the technology for producing clam seedstock and is currently working on the Littleneck clam. This clam has never before

been produced in a hatchery. However, the hatchery staff has been able to bring small batches of Littleneck clams through the most critical stage of development and it seems certain that the techniques for successfully producing Littleneck clam seedstock in the hatchery can be developed. In addition to Littleneck clams the hatchery will soon will doing seedstock development work on Butter clams. A major part of this project will be enabling the Qutekcak hatchery to provide the needed quantities of seedstock for developing populations of clams near the Native villages.

Project Need

This project will provide the villages of Nanwalek, Port Graham and Tatitlek with an easily accessible source of clams for subsistence use. These clams will also be afforded some measure of protection against sea otter predation. With the wild clam populations at a low ebb, the questionable safety as a food source of those that remain in addition to the heavy sea otter predation that these clams are now subjected to, the need to develop safe, protected sources of clams for the villages is greater than ever. If this project is successful it will enable the villages to develop their own supplies of this traditional subsistence food.

Project Design

The goal of this project is to provide the villages of Nanwalek, Port Graham and Tatitlek with a reliable, local source of clams for subsistence use. It is felt that this goal can be achieved if the project objective of placing under cultivation a combined total of approximately two hectares of clams can be met.

There are two aspects to this project. One is producing clam seed in the hatchery and the other is placing the seed in grow-out systems in intertidal areas near the villages. The technology for both these aspects is well understood and can be readily applied to this project. However, in order to get the project up and running, it will be necessary to spend the first year working with state and federal agencies identifying and permitting acceptable grow-out sites and systems. Field crews will be needed from the villages for survey and inventory work on the proposed sites that will likely be required by the permitting agencies. In addition, procedures will need to be developed at the hatchery to produce around 250,000 six millimeter seed annually.

During the second through fifth years of the project village crews will be hired to install grow-out systems in permitted intertidal areas and seed them in. Grow-out systems will be installed and seeded on approximately 0.5 hectares each year. The following are the annual objectives for the project:

Year 1

Work with state and federal agencies to identify and get permitted a combined total of approximately 2 hectares of intertidal area near the villages of Port Graham, Nanwalek and Tatitlek for clam seeding.

Expand clam production at the Qutekcak Shellfish Hatchery to 250,000 six millimeter seed annually.

Year 2 through 5

Install grow-out systems on a combined area for the Port Graham, Nanwalek and Tatitlek villages of approximately 0.5 hectares per year with a capacity of approximately 250,000 six millimeter seed.

Determine the growth rates and survival of clams in the grow-out areas.

Determine the efficacy of various types of passive predator control measures such as fabric and wire mesh covers, bird netting and rack and bag culture.

Schedule

The hatchery work will run the year round. The field season will run from late April to the end of October. Reports will be done quarterly with the annual report issued in January.

Technical Support

Technical assistance will be needed in the hatchery operations, collecting data on grow-out sites, setting up field trials and in testing clams for contamination.

Location

The Qutekcak shellfish hatchery is in Seward. Field work will take place in the Port Graham/Nanwalek area and in the Tatitlek area.

Project Implementation

This project will be implemented by the Chugach Regional Resources Commission, a Native Consortium made up of the five villages and two Native associations in the Chugach region, concerned with natural resource conservation and development.

Coordination

Technical assistance and services will be obtained from private contractors, the Chugach Regional Resources Commission (CRRC), the Alaska Department of Fish & Game (ADF&G), the Alaska Department of Natural Resources (DNR) and the Alaska Department of Environmental Conservation (DEC).

Personnel

Technical assistance with project development and implementation will be primarily provided by David Daisy and Jeff Hetrick. Mr. Daisy, formally a program manager with the ADF&G fisheries enhancement program, has many years experience in Alaska with fisheries project development and implementation. Mr. Hetrick also has many years experience with fisheries enhancement projects in Alaska. He has been extensively involved with the development of the Native aquaculture farms in Prince William Sound and has been working with the Qutekcak shellfish hatchery staff in developing the clam culture techniques.

Budget

Item	Estimated Cost				
	FY 95	FY 96	FY 97	FY 98	FY 99
Personnel	$21.5	$66.4	$68.7	$71.1	$73.6
Travel	$4.2	$7.2	$7.4	$7.9	$8.0
Contractual	$135.0	$103.0	$106.5	$110.3	$114.2
Commodities	$5.5	$27.0	$28.0	$28.9	$30.0
Equipment	$21.0	$15.0	$15.0	$15.0	$15.0
Indirect	$21.1	$26.2	$27.1	$28.1	$29.0
Totals	$ 208.3	$ 244.8	$ 252.7	$ 261.3	$ 269.8

FY 95 Budget Detail

Personnel		
9 mm @ $13.80/hr salary & benefits		$21.5
Travel		
Village/CRRC/Hatchery staff meeting		$4.2
Contractual		
Enabling hatchery to produce 250,000 clam seed	$85.0	
Permitting/technical assistance	$50.0	$135.0
Commodities		
Field & safety gear for 7 crew	$3.5	
Sampling gear	$1.5	
Misc.	$0.5	$5.5
Equipment		
2 workboats @ $10.5		$21.0
Indirect Costs		$21.1
	Total	**$ 208.3**

Project # 95133 (revised) 9/15

Project Title: English Bay River Sockeye Salmon Subsistence Project

Project Leader: Carol Kvasnikoff

Lead Agency: Nanwalek Traditional Council - Sockeye Development Team

Cost of Project: FY 95 - $128.9; FY 96 - $126.0; FY 97 - $168.4

Project Start-up/Completion Dates: March, 1995 to November, 1997

Project Duration: 3 Years

Geographic Area: English Bay Lake system

Contact Person: David Daisy; 3936 Westwood Drive, Anchorage, AK 99517;
Phone 243-8544; Fax 243-1183

Introduction

This project will assist in the effort to build the English Bay sockeye salmon run back to historic levels. The sockeye salmon return to the English Bay River near the villages of Nanwalek and Port Graham was once a primary source of subsistence and cash for the villagers. Over the past 12 years or so the returns have been dropping steadily from the 30,000 range to the current 5,000 range. This has resulted in a complete closure of both the subsistence and the commercial fishery.

The EVOS clean-up effort had a negative impact on the English Bay sockeye. Boom deployment during the early phases of the clean-up trapped a large number of outmigrating sockeye smolt in the boom curtain on the ebbing tides causing high levels of mortality. This, plus the negative impact on other subsistence resources in the area by the spill and the basic health concern that the villagers have with eating fish and marine plants from the spill area, has put emphasis on the need to build the English Bay sockeye return back up to a level that will support heavy subsistence use and a revived commercial fishery.

Studies were undertaken in 1990 by the Chugach Regional Resources Commission (CRRC) in cooperation with ADF&G to determine the best approach to increasing the English Bay sockeye return. In was determined that smolt production in the system was the bottleneck to increasing the returns. A BIA grant was obtained in 1991 to conduct a smolt production pilot project employing lake pen rearing techniques. Eggs were taken from the English Bay sockeye return, incubated to the fry stage at a state facility, returned to the English Bay system for rearing to presmolt in net pens and released into the system in the late fall for outmigration the following spring. The success of this effort lead to a five year grant from the Alaska Science & Technology Foundation to further develop and expand the project.

Around 35 tags were recovered this year from returning adults from the 1991 pilot project. Although there isn't enough information available at this point to determine survival rates, the feasibility of the project has been established. If the project can be made successful over the long run it will be a cost effective method of providing a safe, reliable and badly needed supply of salmon to meet the subsistence and economic needs of the Nanwalek and Port Graham villages.

This project complies with all state policies governing salmon enhancement activities including disease and genetics. It is designed to become self-sustaining beyond the development stage which, if the project remains on schedule, will be completed at the end of the 1997 season. However, additional funds are needed to fully develop the project and keep it on schedule.

Project Need

This project will provide the villages of Nanwalek and Port Graham with the means to increase the local sockeye run. In the past this run has been a vital part of the economic and social fabric of these communities. With the safety and availability of other fisheries resources in the area in doubt, the need to restore and enhance this sockeye run is more important than ever. This resource has the potential of providing these villages with a safe and reliable supply of a traditional subsistence food.

Project Design

Project Goal:

The goal of this project is to develop a self sustaining enhancement program that will increase the annual English Bay sockeye salmon return to a level that will again support the subsistence and commercial fisheries.

Project Objective:

The project objective is the increase the sockeye run to the English Bay River system through a program of producing sockeye smolt from fry reared in pens in the English Bay River system.

Annual Objectives:

In 1995, 1996 and 1997 take 1.2 million English Bay sockeye eggs each year for incubation at the Port Graham Hatchery.

Transfer the resultant fry from the Port Graham hatchery to net pens in the English Bay lakes for rearing to at least eight grams and release into the system just before freeze-up.

Count the number of smolt leaving the system each year and the number of adults entering it. Collect pertinent information from any tagged fish.

Do an acoustic survey of the English Bay system, after the annual smolt outmigration is over, to determine the biomass of hold-over smolt.

Schedule:

The field season runs from April to the end of November each year. The smolt out-migration takes place from early May through June; the pen rearing operation runs from early June to just before freeze-up; the eggtake occurs in August and the acoustical survey is done in late July. Reports are done quarterly with the annual report issued in January.

Technical Support:

Technical assistance is needed in fish culture, tags analysis and the acoustical surveys.

Location:

The English Bay Lake system.

Project Implementation

This project will be implemented by the Nanwalek Sockeye Development Team, an arm of the Nanwalek Traditional Council.

Coordination

Technical assistance and services are being provided by the Chugach Regional Resources Commission (CRRC) and the Alaska Department of Fish & Game (ADF&G).

Personnel

Assistance with program development and implementation is being provided by David Daisy of CRRC. Mr. Daisy, formerly a program manager with the ADF&G fisheries enhancement program, has many years experience in Alaska with fisheries project development and implementation. Thomas Kohler is under contract to CRRC to provide technical training and general field oversight for the program. Mr. Kohler, formerly a fisheries biologist with the ADF&G fisheries enhancement program, has several years of varied experience in Alaska with fisheries enhancement projects. CRRC is also providing the project with accounting services. ADF&G is providing technical assistance in fish culture, tag analysis and limnology work.

Budget

This project will fund only a portion of the total English Bay Sockeye Salmon Enhancement Program budget. The following are those items from the total program budget that will be funded by this project.

Item	Estimated Cost		
	FY 95	FY 96	FY 97
Personnel	$37.3	$39.2	$41.1
Travel	$4.5	$4.7	$5.0
Contractual	$37.0	$25.0	$27.0
Commodities	$17.0	$18.0	$19.0
Equipment	$7.5	$11.3	$47.0
General Administration	$26.5	$27.8	$29.3
Totals	$ 129.8	$ 126.0	$ 168.4

Project # 95134 (revised) 9/15

Project Title: Chenega Bay Mariculture Development Project

Project Leader: Gail Evanoff

Lead Agency: Chenega Bay IRA Council

Cost of Project: FY 95 - $184.3; FY 96 - $77.5; FY 97 - $75.5

Project Start-up/Completion Dates: October, 1994 to September, 1997

Project Duration: 3 years

Geographic Area: Sawmill Bay, Prince William Sound

Contact Person: David Daisy, 3936 Westwood Drive, Anchorage, AK 99517; phone 243-8544, fax 243-1183

Introduction

This project is intended to provide a long term source of subsistence food for the residents of Chenega Bay. It will provide a means for the villagers to maintain their traditional lifestyle in the face of increased and sometimes conflicting use of this area of the Chugach region. There are several advantages to developing shellfish culture operations for subsistence use. First, the operation can be located close to the village, making collecting this food a relatively easy operation. Second, the level of production can be adjusted to any size needed. Third, because it can be well located and adjusted to produce any volume needed, a shellfish culture operation is an ideal mechanism for taking subsistence harvest pressure off of injured resources giving them a chance to recover. Fourth, shellfish culture has minimal impact on the environment.

The project was initiated in 1992, has already gone through feasibility testing, and has now reached the point where a capital outlay and market development are needed to enable it to become self sufficient. Continued technical assistance with the project is also needed.

Project Need

This project is needed to replace lost subsistence resources and economic opportunities and provide the village with a means to develop a local bivalve resource in a manner that provides some level of protection against future man-made disasters such as EVOS. The oil spill amply demonstrated how vulnerable the local marine resource are to disasters such as the oil spill. As well as being an efficient way of utilizing the local marine environment, the mariculture techniques that will be utilized in this project will allow

steps to be taken to protect the shellfish that are under culture from the effects of disasters such as EVOS.

Project Design

Objectives:

Obtain processing and culture equipment that will make the project more efficient and allow it to become self sustaining. This equipment includes a workboat, an efficient anchoring system, a processing facility and processing equipment.

Make the growing and processing operation more efficient.

Develop a marketing plan for the cultured oysters that will maximize the return so that the number of oysters needed for cost recovery is minimized.

Methods:

The shell of the processing facility is already in place. All that is needed is for the interior to be finished to meet health specifications and to be connected to water and electricity. The improved anchoring system design has been developed as have the specs for the processing equipment and workboat.

Schedule:

The processing shed will be finished off as soon as funds are available and water and electricity connected as soon as the ground is thawed. The workboat and processing equipment specifications have already been developed and will be ordered as soon as funds are available. Making the project more efficient will continue through 1997 under the guidance of a mariculture expert. A marketing consultant will be contracted in the spring of 1995 to help develop the marketing plan.

Technical Support:

Mariculture expert, marketing expert.

Location:

The project will take place near the village of Chenega Bay.

Project Implementation

The Chenega Bay IRA Council will be primarily responsible for the project with assistance from the Chugach Regional Resources Commission (CRRC).

Personnel Qualifications

The Chenega Bay IRA Council has been involved with the mariculture project since it began in 1992. CRRC has been providing administrative assistance. Jeff Hetrick of Alaska Aquafarms, Inc. will continue to provide training and technical guidance. Mr. Hetrick has extensive experience in mariculture development in Alaska. A marketing expert has yet to be identified.

Budget

This project will fund only a portion of the total mariculture budget. The following are those items from the budget that will be funded by this project,

Item	Estimated Cost		
	FY 95	FY 96	FY 97
Personnel	$37.5	$37.5	$37.5
Travel	$6.0	$6.0	$6.0
Contractual	$23.3	12.0	10.0
Commodities	$15.0	$15.0	$15.0
Equipment	$85.5	$0.0	$0.0
General Administration	$17.0	$7.0	$7.0
Total	$ 184.3	$ 77.5	$ 75.5

Elders/Youth Conference on Subsistence and the Oil Spill REVISED 10/14/94

Project Number:	95138
Restoration Category:	General Restoration (new)
Proposed By:	ADFG
Cost FY 95:	$85,800
Cost FY 96:	$0
Total Cost:	$85,800
Duration:	1 year
Geographic Area:	Prince William Sound, Lower Cook Inlet, Kodiak Island Borough, Alaska Peninsula
Injured Resource/Service:	Subsistence

INTRODUCTION

The goal of this project is to promote the recovery of injured natural resources and subsistence uses of natural resources through a conference that would involve elders, youth, and other representatives of spill area communities as well as selected scientists involved in spill area research. Conference goals would focus on the role of traditional knowledge in informing people about the spill's effects on natural resources and subsistence uses, in order to contribute to the recovery of natural resources. Through a contract, a facilitator would be responsible for organizing the conference, including designing an agenda and a structure for the conference. The conference would be videotaped. Conference proceedings would be published and a video produced. Both of these products would serve as educational tools to further the recovery of natural resources and subsistence uses through the reintegration of subsistence uses, traditional knowledge, and values into community life.

NEED FOR THE PROJECT

Subsistence uses of natural resources are essential to the economies and ways of life of communities of the oil spill area. After the spill, these uses were severely disrupted due to natural resource injuries and concerns about the safety of using subsistence foods that may have been contaminated by oil. Because of these reduced subsistence uses, opportunities to teach subsistence skills and traditional knowledge have also been diminished. As noted in the draft Oil Spill Restoration Plan, "the more time users spend away from subsistence activities, the less

likely they will return to it" (p 32). The restoration strategy for subsistence, as presented in the draft plan (pp. 32-33), has four parts, including an objective "to accelerate recovery of subsistence resources and services." One means to achieve this goal is "through increasing availability, reliability, or quality of subsistence resources, or increasing the confidence of subsistence users."

Increasing the availability of subsistence resources and the confidence of subsistence users may be achieved by a gathering of knowledgeable individuals (including elders) and young people in order to identify the natural resource injuries and other problems raised by the spill and the means to address these issues. They could be joined by a limited number of scientists who are engaged in spill-related research. The conference would draw upon traditional knowledge and the experience of community residents in facing past crises. A goal would be to share observations about natural resources in the spill area and recommend activities that could assist people in understanding the present conditions of these resources and in contributing to their recovery. There has been no similar opportunity for the communities of the spill area. which depend upon the natural resources for subsistence, to discuss their common experiences, concerns, and plans as proposed for this conference.

The Draft *Exxon Valdez* Oil Spill Restoration Plan (p. 33) states that, regarding subsistence, "one indication that recovery has occurred is when the cultural values provided by gathering, preparing, and sharing food are reintegrated into community life" (p. 33). The conference will contribute to this goal through the discussion and dissemination of traditional knowledge about resource conservation and subsistence uses, and about the common experiences shared by subsistence users since the spill. This would complement the work done under the Subsistence Foods Testing Project (projects 93017 and 94279), which has principally involved bringing scientific information to subsistence users. Additionally, this project will assist with the restoration of subsistence through monitoring of the recovery of subsistence uses. The information discussed at the conference will provide a picture of the present status of subsistence and natural resources, which may in turn be used to direct future restoration actions.

PROJECT DESIGN

A. Objectives

Objectives include participation by representatives of communities of the oil spill area in a conference, during which injured natural resources and subsistence uses are identified and discussed. Means to assist in the recovery of these resources and uses will be identified. Written conference proceedings and a video which summarize the conference and its findings and recommendations will also be produced and distributed.

B. Methods

A professional services contract will be awarded to design the conference agenda and serve as the conference moderator. The contractor will consult with spill area communities as appropriate to set the agenda. The contractor will also be responsible for preparing the conference proceedings. A separate contract will be awarded to videotape the conference and produce a video presentation of the conference (see below).

Among the potential topics for discussion are:

1. What has been the common experience of subsistence users of spill-area communities since the oil spill? What has been lost? What has been gained? Are there differences between regions?

2. Is there traditional knowledge available to inform subsistence users and others about the spill's effect on natural resources? How can traditional knowledge and skills be used to assist in the recovery of injured resources? Possible topics include identification of alternative resources, traditional conservation methods, and efficient harvest and processing techniques.

3. Is there traditional knowledge available to inform subsistence users about the spill's effects on the safety of subsistence foods?

4. What actions need to be taken by communities to re-invigorate subsistence uses? Are there particular skills and knowledge which need to be emphasized?

5. How have people of the spill area dealt with disasters in the past? What can we learn from those experiences?

6. Given what we have learned, how can communities prepare for the possibility of future disasters and threats to subsistence?

7. How can the exchange of information about injured resources between communities, agencies, and scientists be facilitated in the future?

The conference will be video-taped and audio-taped. A proceedings volume will be prepared. A summary video, approximately 30 minutes in length, will also be produced to present the conference highlights and recommendations. It is intended that the proceedings and video be used as educational tools to promote an exchange of information and to strengthen subsistence traditions that have been weakened since the spill.

The conference would last one or two days. Each community of the spill area (approximately 20 communities) would nominate one elder, two students (high school or college aged), and one additional representative. The exact format for the conference would need to be determined by the contractor after consultation with the communities. It would likely entail several formats, including but not limited to formal presentations, panel discussions, round tables, and question/answer periods. Participants will be encouraged to report back to their communities about the conference. This could take the form of school papers and oral presentations, and community meetings and contributions to newsletters.

C. Schedule

November 1, 1994	Project approval
Nov - Dec 1994	Develop contract guidelines, evaluate bids, award contract
Jan - Feb 1995	Conference planning
March 1995	Conference
April - June 1995	Production of conference proceedings and videos
July - August 1995	Distribution of materials
September 1995	Complete project final report

D. Technical Support

None required.

E. Location

The proposed conference will take place in Anchorage, primarily because of its centralized location. If feasible in terms of cost and facilities, an alternative location can be considered.

PROJECT IMPLEMENTATION

The Division of Subsistence of the Alaska Department of Fish and Game will coordinate the implementation of this project. The coordination will entail preparing contract proposals for competitive bids, evaluating proposals, and monitoring the performance of the contractors. The division will also handle the logistics of the conference, including meeting facilities and participants' travel and accommodations. Professional services contracts (or subcontracts) would be awarded to design the conference, prepare the proceedings, videotape the conference, and produce an informational video which summarizes the conference findings.

COORDINATION OF INTEGRATED RESEARCH EFFORT

Information about the status of injured natural resources and potential means toward recovery based upon scientific findings can be integrated into the conference. Conference findings, including observations by subsistence harvesters of natural resource populations, will be available for use by other researchers through written conference proceedings and videotapes. Other proposed subsistence restoration projects (e.g., 95244 - Seal and Sea Otter Cooperative Harvest Assistance, 95428 - Subsistence Planning) also have public information components that will benefit from the information which is shared through the conference and its resultant products. This project would complement the work done under the Subsistence Foods Testing project (93017, 94279, 95279).

FY 95 BUDGET ($K)

Personnel	16.3
Travel	44.4
Contractual	21.0
Commodities	0.2
Equipment	0.0
Subtotal	72.5
Gen. Admin.	3.9
Total	85.8

NOTE: Personnel funds can be reduced by $9,400 if Project 95052 is funded (the agency coordination function for Project 95138 would be performed by Subsistence Division personnel funded under Project 95052).

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1011 E. Tudor Rd.
Anchorage, Alaska 99503-6199

IN REPLY REFER TO:

James R. Ayers, Executive Director
Exxon Valdez Oil Spill Trustee Council
Restoration Office
645 G Street
Suite 401
Anchorage, Alaska 99501-3451

OCT 5 1994

Dear Mr. Ayers:

Thank you for your recommendations regarding the scope and scale of forage fish investigations for FY 95 in your September 7, 1994 letter. As planned, a forage fish work session was held in Anchorage on September 19-20 and another work session was held September 26-27. Through a combination of these meetings, the comments from the chief scientist, and much work, we have developed a Seabird/Forage Fish package for FY95 and are now functioning as a team rather than several independent projects. The cover proposal and the brief project descriptions for each subproject are attached.

We have tried to be responsive to the chief scientist's comments, and to that end, we reduced the project budget from about $2.4 million to about $1.4 million. However, reducing the budget caused a reduction in the scope of work. We reduced the area of the Forage Fish Assessment (95163A) component from all of Prince William Sound to a portion of the Sound, and we reduced the field season from April through September to just July and August. We also deleted the assessment of demersal fish in the Pigeon Guillemot (95163F) component. The Puffin component (95163D) was reduced to a minimal feasibility study.

If more funds are available, an additional cruise for the Forage Fish Assessment component would provide valuable data for the seabird pre-laying period. For about an additional $100K (a 25% increase) the total amount of data collected could be increased 50%, because of fixed costs associated with the project that would not increase.

Below we have addressed the chief scientist's comments on the Seabird/Forage Fish project. Brief project descriptions for each subproject have been modified to respond to comments specific to the subprojects.

Program Management and Integration

We agree with the chief scientist's comments that projects addressing food limitation need to be carefully coordinated. In our recent work sessions, we have made great strides in coordination among the Seabird/Forage Fish project components and we will continue to work out details throughout the winter with monthly coordination meetings. All the Principal Investigators of the subprojects recognize that complete integration is a necessity to put forth a comprehensive, efficient research effort to address food limitation questions that involve multiple trophic levels. In the cover proposal we have outlined the sharing of data and logistical support among projects; details on the specific needs of each project will be addressed in our monthly coordination meetings. We will also discuss contingency planning for integral parts of the package and outline alternatives.

Quality assurance will be accomplished in many ways. All detailed project descriptions will be reviewed by all Principal Investigators, by the proposed Seabird/Forage Fish project Technical Steering Committee, and by the Trustee Council Interim Review Board. Annual reports, including the synthesis report, will go through the same review process. A biometrician will be contracted to review sampling designs and data analyses. Interim progress will be tracked by review of overall progress at the annual January Science Workshop and by review of the annual subproject reports and annual synthesis report.

The Principal Investigators for each subproject of the Seabird/Forage Fish project have appointed us (David Irons and Bruce Wright) as Interim Project Coordinators for this project. We plan to take on the program management tasks outlined in the subproject brief project description (95163I), including but not limited to, coordination within and among projects to maximize data and logistics sharing, facilitating communications with the oil spill restoration office, and scheduling performance milestones and ensuring they are met. We plan to hire a Project Coordinator midway through FY95 to assume these important tasks, and we are committed to identifying an individual who is acceptable to all Principal Investigators and can work effectively with their counterparts in SEA, Nearshore Vertebrate Predators, and other relevant EVOS projects.

Coordination between the Seabird/Forage Fish project and other projects has already begun. Dr. Irons contacted Dr. Cooney of the SEA package and set up the first coordination meeting for mid October, which will result in a list of issues and a schedule of coordination meetings. Dr. Cooney was very interested and positive about coordination of the two packages. Dr. Cooney and Dr. Irons are confident that the two packages can be coordinated to ensure efficiency in the Exxon Valdez Trustee Council Work Plan. A coordination plan with the Nearshore Vertebrate Predator project, other marine bird projects, and the information management projects will be set up in October. All data that are collected by the Seabird/Forage Fish project will be available to the SEA and the Trustee Council data base management systems.

Research Program Design

We agree with the chief scientist's recommendation to focus on pigeon guillemots and black-legged kittiwakes initially. Because puffins offer a potential cost-saving method of sampling forage fish, we propose to conduct a small feasibility study in the core sampling area around Naked and Smith Islands to determine if those puffin colonies are accessible for use.

Regarding the Pigeon Guillemot project (old number 94173, new number 95163F), past studies have shown that guillemots appear to prefer sand lance, a schooling fish, over demersal fish, and some evidence suggests their reproductive success tends to be higher when they feed on sand lance compared to demersal fish. In the late 1970's guillemots at Naked Island ate many sand lance, but in 1994 birds at Naked Island ate few sand lance or other schooling fish and many demersal fish, while birds at Jackpot Island ate many schooling fish (i.e., herring and smelt but not sand lance). We feel it is important to assess the abundance and species composition of demersal fish as well as that of schooling fish. However, considering the larger question of food limitation for several species, the assessment of demersal fish is less important than assessment of schooling fish. To try to meet the budget recommended by the chief scientist, we removed the work relating to the assessment of demersal fish from the FY95 Pigeon Guillemot proposal.

We agree with the chief scientist that hydroacoustic surveys and net sampling provide data on only the relative abundance and distribution of forage fish and we recognize that forage fish might be present but unavailable to birds. There are three subprojects that will provide data to determine the availability of forage fish to birds. The Forage Fish Assessment/Birds component will collect bird distribution and behavior data simultaneously with hydroacoustic surveys. These data will provide information on two aspects of fish availability: depth of fish schools and distance from bird colonies to fish. The Kittiwake and Pigeon Guillemot components will provide data on foraging ranges from colonies, diets of birds, and habitats used by foraging birds. After data from 1994 are analyzed, we will know if the Forage Fish Assessment component is sufficiently sampling habitat used by foraging seabirds. If it is not, the sampling design will be restratified to sample more in areas used by birds.

Integration with SEA (95320)

Regarding integration with the SEA project, as mentioned earlier, Dr. Cooney and Dr. Irons discussed the importance of coordinating the two projects and planned a meeting in mid October to discuss coordination and plan future meetings. The principal investigators of both projects are aware of the necessity of good coordination. As the chief scientist pointed out, it is essential that the hydroacoustic data from both projects be compatible to maximize the coverage of data on distribution, abundance, and composition of forage fish (which include juvenile herring and salmon) in Prince William Sound. All other opportunities to collaborate and share data or logistics will be explored. All data collected by the Seabird/Forage Fish project will be made available to the SEA database.

We feel that we are well on the way to developing an efficient, comprehensive, integrated research effort that will provide valuable information on the question of whether food is limiting the recovery of injured resources.

Bruce Wright and I coordinated closely in writing this letter, but he was unable to be present to sign it.

Sincerely,

David B. Irons

Co-Project Coordinator

Seabird/Forage Fish

Project Number:	95163A-I
Restoration Category:	Research (new)
Proposed By:	DOI, NOAA, ADFG
Cost FY 95:	$1,446K (includes write-up of 1995 report)
Cost FY 96:	$2,400K (includes write-up of 1996 report)
Total Cost:	Unknown
Duration:	5 years
Geographic area:	Prince William Sound
Injured Resource/Service:	Multiple resources

INTRODUCTION

Populations of several piscivorous marine bird and mammal species have declined in Prince William Sound (PWS) since 1972; conversely, species that feed on benthic invertebrates have not declined. Marbled murrelets, pigeon guillemots, arctic terns, black-legged kittiwakes, glaucous-winged gulls, tufted puffins, and harbor seals feed primarily on schooling forage fish and have declined by more than 50%. Harlequin ducks, goldeneyes, black oystercatchers, and sea otters feed on benthic invertebrates and have not declined throughout PWS, although some species were affected by the *Exxon Valdez* oil spill. This pattern of declines in piscivorous species and absence of declines in species consuming benthic invertebrates suggests that marked changes in the forage fish community abundance, distribution, and species composition occurred over the last 20 years. Sand lance was an important component of pigeon guillemot diets in the late 1970's that has virtually disappeared from their diets in the 1990's.

If populations of piscivorous seabirds that were injured by the *Exxon Valdez* oil spill (i.e., common murre, marbled murrelet, and pigeon guillemot) are currently limited by food, recovery of these populations is not likely. Therefore, an important hypothesis to be addressed by restoration research is that the recovery of injured species is limited by food. The goal of this study is to determine if the distribution, abundance, availability, and species composition of forage fish in PWS are limiting recovery of injured seabird populations.

Reproductive success of seabirds is largely dependent upon foraging constraints experienced by breeding adults. Previous studies of seabird reproductive energetics have indicated that

productivity is energy-limited. Forage fish vary considerably in energy density. Therefore, knowledge of energy content of prey provisioned to seabird nestlings is critical for understanding the effects of changes in the forage fish resources on the productivity of seabird populations.

To address questions about food limitation for seabirds, species must be studied for which productivity and parameters that indicate food stress can be measured. Surface-feeding species and diving species should each be studied because of differential ability to pursue prey. In PWS, kittiwakes (surface feeders) and pigeon guillmots (divers) are the two most appropriate species to study. Both species are widespread and the necessary data can be collected for them relatively easily.

Food limitation may have been the cause for recent low seabird productivity and consequent population declines in other parts of Alaska. Some black-legged kittiwake colonies in the Gulf of Alaska have declined over the past ten to fifteen years. There are indications that capelin, an important component of seabird diets in the 1970's, declined drastically in 1978 and has remained low. Kittiwakes and murres at some colonies in the Bering Sea have suffered chronically low productivity in the past 15 years and food supply has been implicated as the prime factor.

Investigations of the relationships between pelagic seabirds and their prey have been conducted in the Gulf of Alaska, the Bering Sea, the North Atlantic Ocean, and the Southern Ocean using counts of birds and associated hydroacoustic data. This work has been short-term and the general objective has been to understand the mechanisms (e.g., oceanographic features) that make prey available to seabirds. However, there have been multi-year studies in limited areas of the North Atlantic that compared relative abundance of forage fish to reproductive performance in seabirds. Relationships between some seabird foraging and reproductive parameters and forage fish relative abundance were found that indicated food was more limiting in some years than others.

Assessing the abundance and composition of seabird prey in a large area, such as the Gulf of Alaska or the Bering Sea, is a very complex, expensive, and difficult task. However, nesting tufted puffins have been used to sample species composition of the fish communities in selected areas of the northern Gulf of Alaska. This technique is potentially useful and inexpensive, but needs more ground truthing with independent data on fish composition before it can be substituted for shipboard net sampling.

NEED FOR THE PROJECT

The *Exxon Valdez* Oil Spill Trustee Council scientists identified the long-term declines in PWS piscivorous marine bird and mammal species as a high-priority ecosystem issue.

Several injured species were in decline before the oil spill and might not recover due to food limitation. Ecosystem processes are complex and involve multiple resources at several trophic levels. Therefore, restoration projects to address this issue must involve an integrated, collaborative, multi-disciplinary approach.

The Seabird/Forage Fish project has several interrelated components (Table 1) that together address the food limitation hypothesis. These components are ecologically and conceptually linked (Figure 1) and therefore must be conducted concurrently and collaboratively to achieve the project goals. Each subproject is dependent upon others for data and logistical support. The Forage Fish Assessment and Forage Fish Assessment/Birds components provide information on amount and quality of seabird prey available. The Puffin project might provide an inexpensive method to assess fish composition. The Seabird Energetics and Forage Fish Composition components provide information on the energetic constraints that prey availability and quality place on seabird productivity. The Pigeon Guillemot and Kittiwake components provide information on the extent of food stress and on reproductive success of seabirds. The Forage Fish Diets component investigates the overlap in diets between forage fish and juvenile salmon. Together, these components provide information on how the amount and quality of prey might limit seabird productivity and population recovery.

The Seabird/Forage Fish project will ensure that a comprehensive, cooperative, and efficient research effort is developed to collect information to address the food limitation hypothesis. This information is crucial for understanding the factors constraining recovery of marine birds and mammals damaged by the spill and for designing management initiatives to enhance productivity of species that are failing to recover.

PROJECT DESIGN

A. Objectives

To determine if the distribution, abundance, and species composition of forage fish are limiting recovery of injured seabird resources.

B. Methods

The Seabird/Forage Fish project comprises nine subprojects, the specific objectives and methods of which are outlined in the attached subproject descriptions.

C. Schedule

October 1994-May 1995	Prepare for field season Monthly coordination meetings of Principal Investigators Regularly scheduled coordination meetings with SEA and other projects
May-September 1995	Field work
October-December 1995	Data analysis
January 1996	Presentation at Science Workshop
31 January 1996	Draft annual reports due
February-March 1996	Reports reviewed by Technical Steering Committee, Trustee Core Reviewers, and other Principal Investigators
March 1996	Prepare Fy 96 Proposal
31 March 1996	Final annual reports due
May-September 1996	Field Work
30 June 1996	Draft annual synthesis report due
July-August 1996	Reports reviewed by Technical Steering Committee, Trustee Core Reviewers and other Principal Investigators
31 August 1996	Final annual synthesis report due

D. Technical Support

We plan to establish a Technical Steering Committee of three experts on seabird/forage fish interactions that will provide external review, advice, and guidance on the technical aspects of the overall project as well as on specific components.

Requirements for technical support for each component are identified in attached subproject descriptions.

E. Location

The focus of the study is in Prince William Sound (Figure 2) in 1995. In future years it is expected to expand into the northern Gulf of Alaska. Specific study sites are shown in Figure 2.

PROJECT IMPLEMENTATION

The Fish and Wildlife Service, National Biological Survey, National Marine Fisheries Service, Alaska Department of Fish and Game, University of Alaska, and Texas A&M University will collaborate on this project. Opportunities for public involvement in data collection and synthesis and review of reports are present in the subprojects. The responsibilities for

implementing this program were divided up based on expertise and prior experience with the methods, venues, and resources proposed for the research.

COORDINATION OF INTEGRATED RESEARCH EFFORT

There will be two major elements of coordination to ensure efficiency in this research program: coordination among the subprojects within the Seabird/Forage Fish project and coordination between the Seabird/Forage Fish project and other projects. Because of the links inherent in research involving multiple trophic levels, the components of the Seabird/Forage Fish project are highly dependent upon each other (Figure 3). The Forage Fish Diets component will provide information to the Forage Fish Assessment component on the dietary overlap among species, which will provide insight into possible competition. The Puffin component is linked with the Forage Fish Assessment component in that it might be another method of sampling forage fish; the Puffin study will also provide samples to the Seabird Energetics component. The Forage Fish Assessment component will provide data on fish distribution, abundance, and species composition to the Forage Fish Assessment/Birds, the Pigeon Guillemot, and the Kittiwake components. The Forage Fish Assessment/Birds component will provide data on foraging behavior in relation to fish distribution and abundance to the Pigeon Guillemot and Kittiwake components. The Pigeon Guillemot and Kittiwake components will share information on the distribution of foraging birds and will compare their data to those of the Forage Fish Assessment/Bird component. Also, much data will be shared between the Seabird Energetics component and the Pigeon Guillemot and Kittiwake components. The Forage Fish Composition component will provide data to the Seabird Energetics component.

Logistics will be coordinated to minimize cost and maximize data collection through the program management and integration process and regular meetings among the Principal Investigators. The Forage Fish Assessment component will provide logistical support for the Forage Fish Assessment/Birds component. The Pigeon Guillemot, Kittiwake, Puffin, and Seabird Energetics components will share field camps and logistical support where practical.

The Seabird/Forage Fish project will coordinate with several other projects in PWS to increase the overall efficiency of the *Exxon Valdez* Trustee Council work plan (Figure 4). Coordination with the SEA study is imperative to maximize sharing of data and logistical support. All data collected by the Seabird/Forage Fish project will be available to the data base management system that is maintained by the SEA program (95320J) and to the oil spill office information management system (95089). Data collected on forage fish distribution, abundance, composition, and energy content will be provided to the marine mammal studies and other marine bird projects. The Nearshore Vertebrate Predators project will collect information on ecosystem health using bioindicators, which will provide valuable information on the level of toxins that might affect seabirds.

The program coordinator for the Seabird/Forage Fish project will ensure that coordination within the project and between this and other projects occurs, facilitate communication with the oil spill restoration office, ensure that performance milestones are met, prepare annual synthesis presentations and reports, and explore opportunities for data management and systems modelling in cooperation with SEA project (95320J) and Project 95089.

FY 95 BUDGET ($K)

See Table 1 for a list of subproject budget totals and attached subproject descriptions for budgets of each subproject.

Table 1. List of subprojects in the Marine Bird/Forage Fish project (95163A-I) and their budgets.

New Number	Old Number	Subproject Name	Proposed Budget($K)	Revised Budget($K)
95163 A	95163	Forage Fish Assessment	842	483
95163 B	95163	Forage Fish Assessment/Birds	221	155
96163 C	95163	Forage Fish Diets	258	77
95163 D	95019	Puffins as Samplers	271	32
95163 E	95033	Kittiwakes as Indicators	199	180
95163 F	95173	Pigeon Guillemot Recovery	409	260
95163 G	BAA-118	Seabird Energetics	141	141
95163 H	BAA-120	Energy Composition of Fish	43	43
95163 I	-	Program Management and Integration	-	75
		TOTAL	$2,384K	$1,446K

Table 2. Matrix of temporal data needs for abundance, distribution, and species composition of forage fish by subproject and proposed cruise dates.

	April	May	June	July	August	September
Pigeon Guillemot Recovery				----------		
Kittiwakes as Indicaters	----------	----------	----------	----------	----------	
Puffins as Samplers					----------	
Seabird Energetics				----------		
Proposed Cruises				----------	----------	

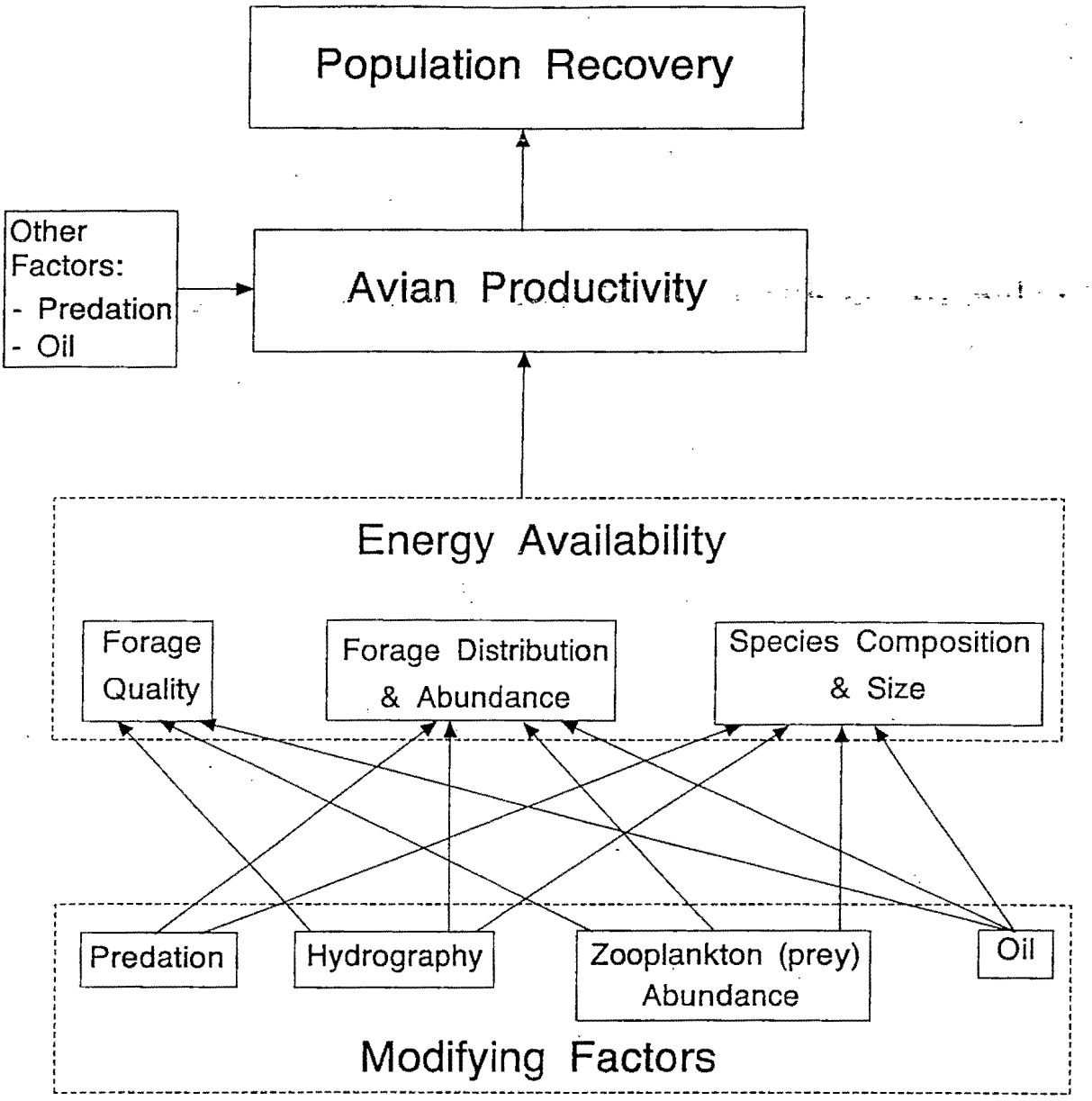

Figure 1. Conceptual framework for the Seabird/Forage Fish project (95163A-I) showing ecological links to factors that may control avian productivity and recovery.

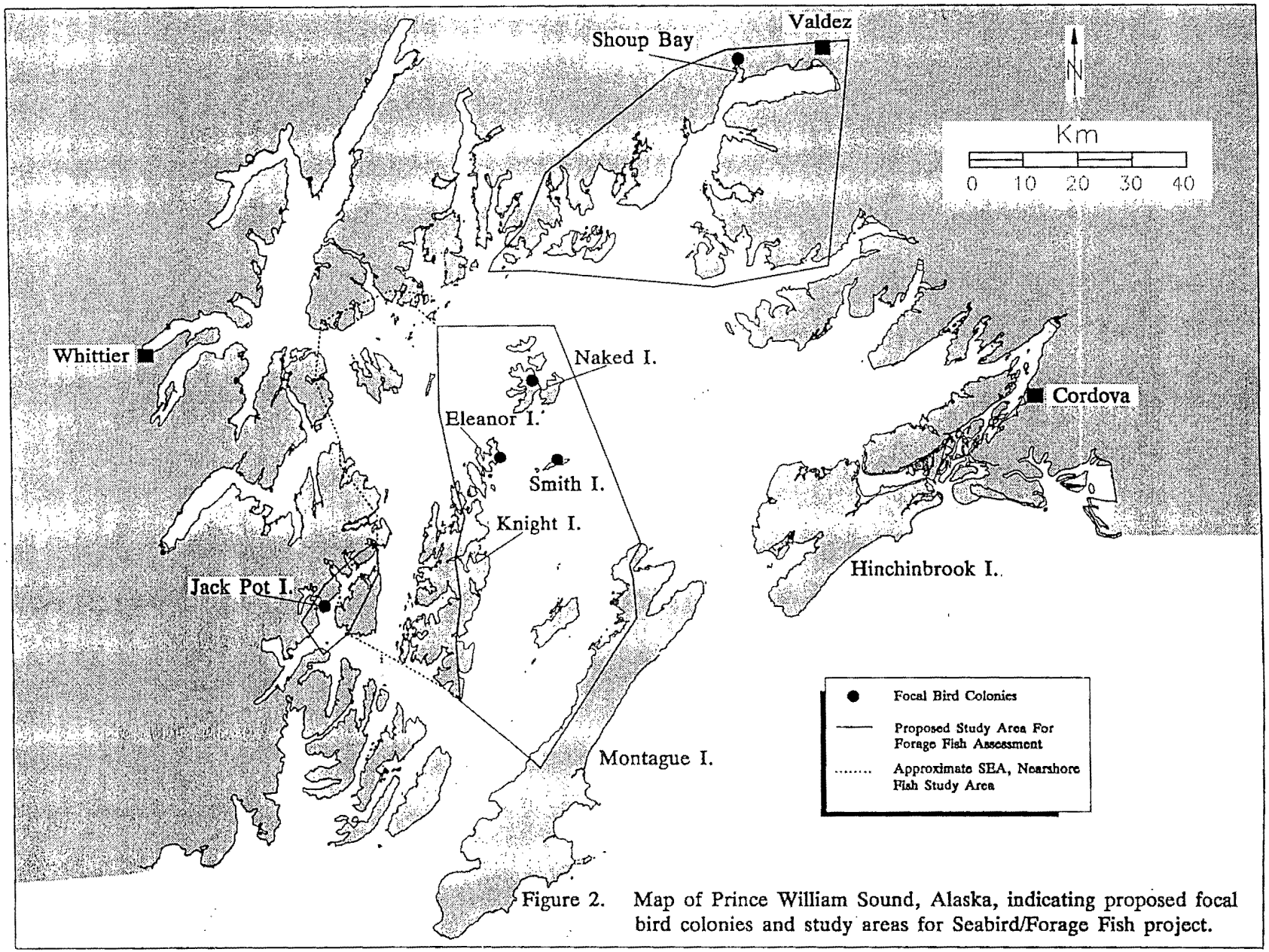

Figure 2. Map of Prince William Sound, Alaska, indicating proposed focal bird colonies and study areas for Seabird/Forage Fish project.

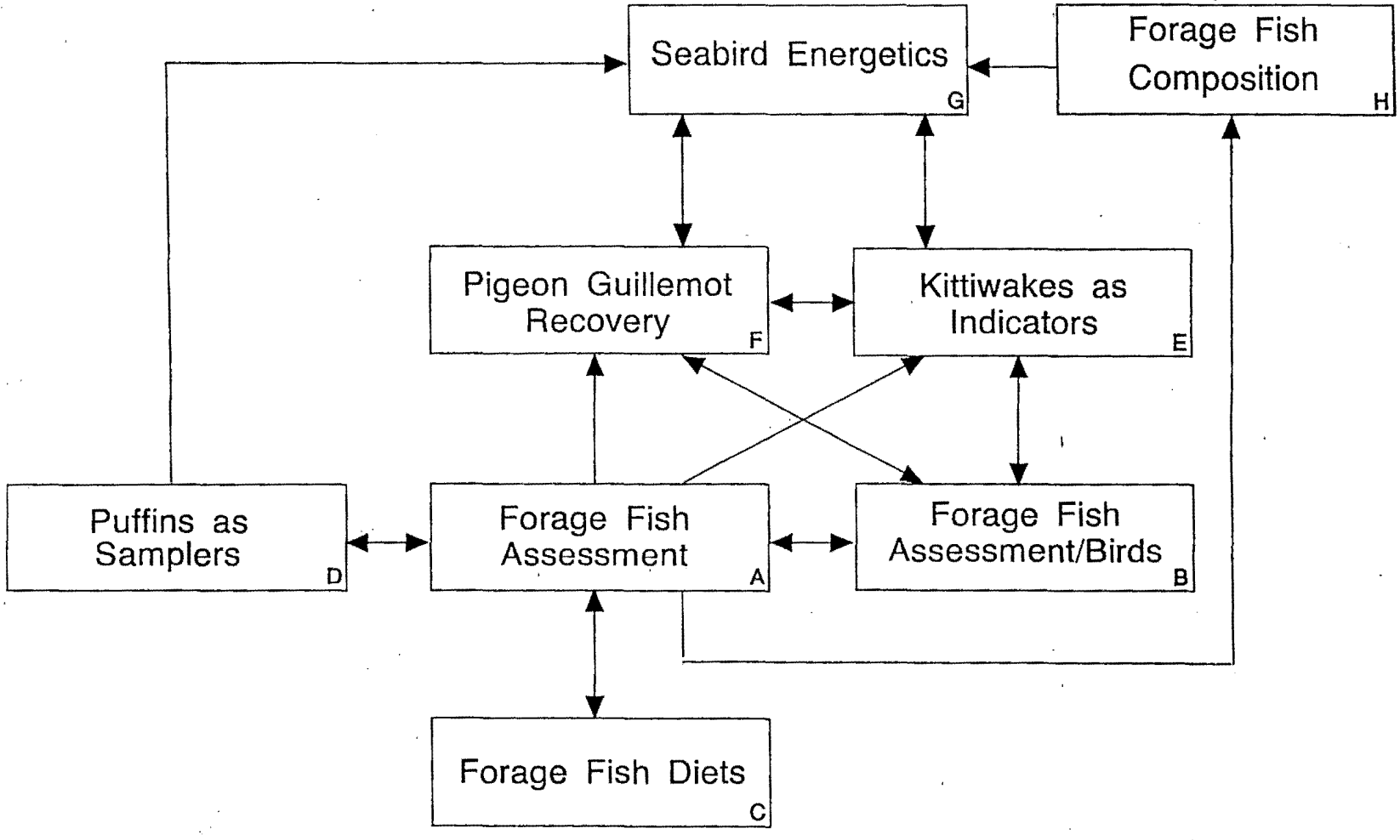

Figure 3. Data exchange among the Seabird/Forage Fish subprojects (95163A-H). Subprojects are indicated by the project letter.

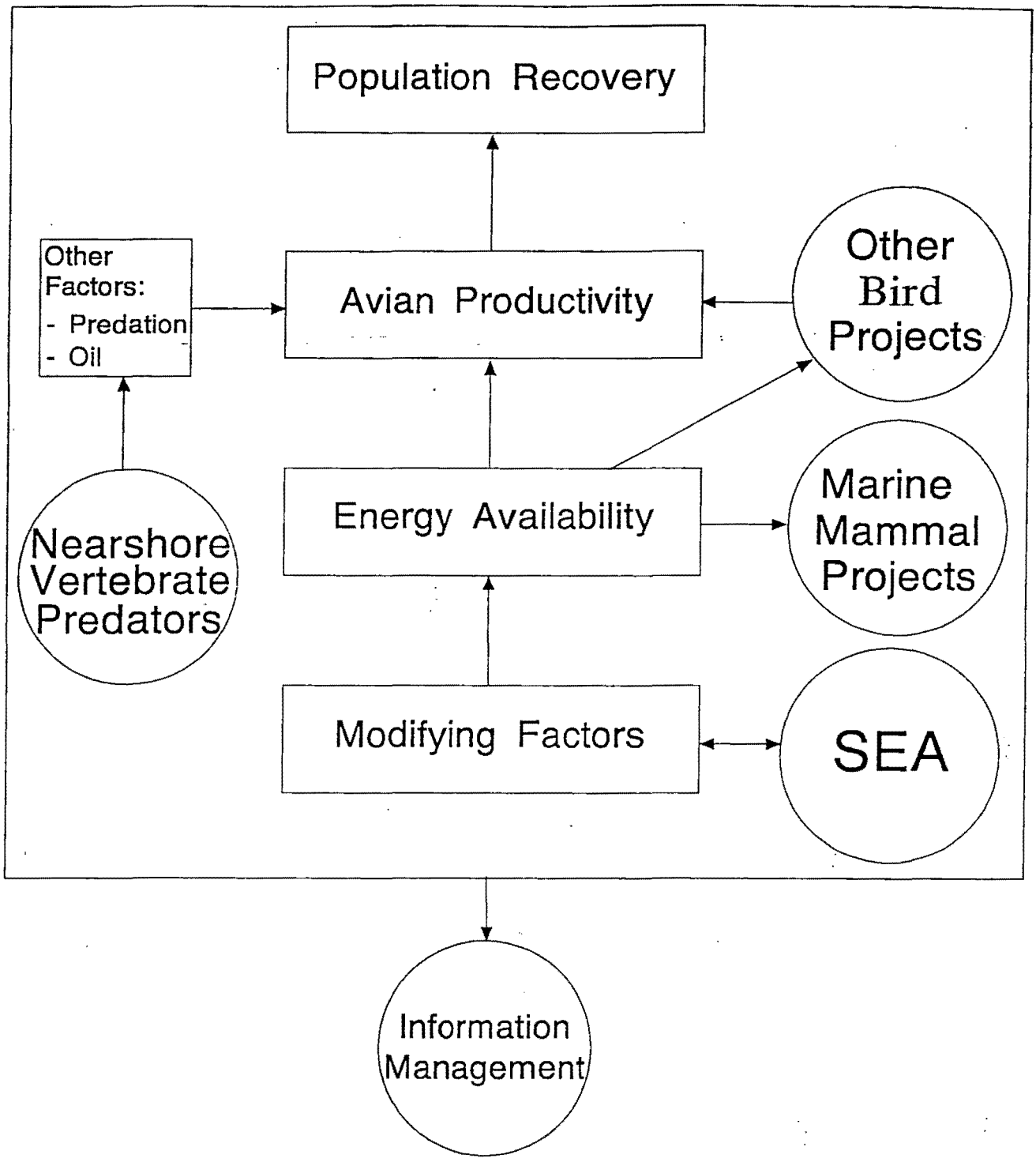

Figure 4. Coordination and information flow between Seabird/Forage Fish project and other projects, which include: SEA-95320 E,H,I,N,T,U; nearshore 95025C; marine mammal projects 95001, 95064, 95117; murre & murrelet projects 95039 & 95031; and the information management projects 95089 and 95320J.

Abundance and Distribution of Forage Fish and Their Influence on Recovery of Injured Species

Project Number:	95163A (formerly 95163)
Restoration Category:	Research (continuation of 94163)
Proposed By:	NOAA
Cooperating Agencies:	DOI & ADFG
Cost FY95:	$482,700
Cost FY96:	$482,700
Total Cost:	Unknown
Duration:	6 years minimum
Geographic Area:	Prince William Sound
Injured Resource/Service:	Multiple Resources

INTRODUCTION

A better understanding is needed of how prey availability affects distribution, abundance, growth, and reproductive success of apex predators. Efforts to restore predatory species affected by the oil spill, particularly harbor seals, pigeon guillemots, marbled murrelets, and black-legged kittiwakes, could be delayed or completely unsuccessful without understanding distribution, abundance, and availability of important forage fish including herring, pollock, sand lance, capelin, and invertebrate species such as macrozooplankton and squid.

NEED FOR THE PROJECT

This is a core component of the Seabird/Forage Fish project (95163A-I), a multi-disciplinary project designed to understand the Prince William Sound (PWS) food web and the associated effects on the injured species.

This project will concentrate on determining distribution, abundance, and availability of important prey species (e.g., herring, pollock, sand lance, capelin, macrozooplankton, squid) to predatory species affected by the oil spill (harbor seals, pigeon guillemots, marbled murrelets, black-legged kittiwakes). This information, trophic position and niche overlap among species, will be used to establish the basic structure of future ecosystem models. The

models of changing oceanographic regimes and prey species productivity and distribution are necessary for understanding recovery of predatory species, and useful in guiding recovery activities.

PROJECT DESIGN

This project will evaluate existing field methods used in determining distribution, abundance, availability, and class composition of forage fish. Provisions will be included to model effects of changing oceanographic regimes on forage fish species' distribution, abundance, and productivity.

The 1995 sampling program will be a continuation of the 1994 pilot project (94163) to determine distribution, densities, and species composition of forage fish species. Field surveys will determine where apex predators forage (95163B), and this project (95162A) will determine distribution, abundance, and availability of forage fish of both nearshore and offshore waters within selected areas of PWS. Ecosystem models to estimate biomass and productivity of forage fish species will be evaluated and initiated (95163I) in coordination with SEA project (95320J).

A. Objectives

Overall objectives: Determine temporal and spatial distribution, abundance, species composition, and availability of important prey species (e.g., herring, pollock, sand lance, capelin, macrozooplankton, squid) in PWS waters. Determine how important biotic and abiotic factors affect both short- and long-term distribution and abundance of prey species in the oil spill area. Determine how predator distribution, abundance, and foraging strategy coincide with forage fish distribution, abundance, and availability.

1995 objectives:

1. Evaluate existing field methods used in determining distribution, abundance and availability of forage fish.
2. Determine temporal and spatial distribution, abundance, and availability of prey species using hydroacoustic surveys and net sampling.
3. Investigate the relationships between forage fish abundance and distribution to oceanographic parameters.
4. Initiate development of ecosystem models to understand factors influencing distribution, abundance, and composition of forage fish.
5. Investigate relationships of forage fish abundance to seabird and marine mammal abundance and productivity, in conjunction with complementary studies (95163 B-I, 95001, 95031, 95039, 95064, 95117, 95320H, 95320N, and 94320T).

B. Methods

Conduct both coarse- and fine-scale hydroacoustic surveys and determine forage fish composition and sizes by net sampling. Coarse scale surveys will consist of line transects spaced throughout the study area. Fine-scale surveys will be located at sites known to be seabird or marine mammal feeding areas. Both coarse- and fine-scale surveys will be conducted during the two 20-day surveys. Survey timing is during the times most important for seabird nesting, July and August (see Figure 1). Four permanent hydroacoustics stations will be established to observe temporal patterns in prey abundances within and between years.

Figure 1. Periods in which forage fish distribution and abundance data, and samples should be collected to support 95163 projects.

Species/ Project #	April		May		June		July		August		Sept.	
Puffins/ 95163D									X	X	X	
Kittiwakes/ 95163E	X	X	X	X	X	X	X	X	X	X		
Pigeon Guillemots/ 95163F							X	X	X			
Seabird Energetics/ 95163G							X	X	X	X		

During hydroacoustic surveys, simultaneous seabird and marine mammal surveys will take place from the same vessel (95163B). Data from this study will be used to understand foraging behavior in relation to abundance and distribution of prey. These data will also be combined with data from other seabird studies to compare relative fish abundance to foraging behavior and reproductive success, marbled murrelets (95031), pigeon guillemots (95163F), and black-legged kittiwakes (95163E).

Forage fish will be sampled in nearshore and offshore areas using nets. Each species will be identified and length and weight measured on a minimum of 150 individuals randomly selected in each sample. Fifteen fish from each species will be preserved from each sample for later analysis of stomach contents (95163C). Additional samples will be collected for later lipid and stable isotope analysis (94320I).

C. Schedule

The forage fish surveys will be conducted under contract. The contractor will conduct two 20-day hydroacoustic and net sampling surveys during July and August. Annual reports will include progress on refining the forage fish models. A project status report will be submitted by the contractor in December, 1994 (94163), which will discuss existing field methods used in determining distribution, abundance, and availability of important prey species, and the process and justifications for selected survey techniques. The report will present and discuss the results of the field surveys including locations of forage fish, and when possible, the biomass of these species, and forage fish prey, as determined from stomach content analysis.

The 1995 report, due April 1996, will present and discuss the results of the FY95 field surveys. The contractor, in collaboration with NOAA, ADF&G, USFWS, 95320J, and 95163I, will report on the correlation of forage fish distribution and abundance with seabirds (marbled murrelet, pigeon guillemot, black-legged kittiwake) and marine mammal abundance and productivity. The report will also describe and evaluate ecological models to estimate productivity of important prey species, and a sampling program to fulfill requirements of ecological models. Annual reports will include progress on refining the productivity models. The contractor will participate in development of a synthesis report prepared by 95163I.

July 1995 - August 1995	Contractor field sampling
September 1995 - 31 March 1996	Analyze data and prepare annual report

D. Technical Support

This project will generate data which will be useful to the monitoring projects and studies currently underway in PWS. To insure access to these data, the information collected from this project will be incorporated into a data base managed by the Trustee Council (95089) and SEA project (95320J).

E. Location

This project will concentrate its initial activities within PWS. The research area consists of three core study blocks: Valdez Arm south to and including the waters around Glacier and Bligh Islands, waters around Naked Island south to The Needles, and waters in the Jackpot Bay/Dangerous Passage area. These areas are not key survey areas for the SEA hydroacoustic studies (95320H and 95320N). However, some of the data from the SEA hydroacoustic studies may be useful in refining the productivity models.

PROJECT IMPLEMENTATION

This project will be contracted and coordinated by NOAA with cooperative components conducted by ADF&G and USFWS.

COORDINATION OF INTEGRATED RESEARCH EFFORT

There are two major components of coordination to insure efficiency in this research package, coordination among the subprojects within the Seabird/Forage Fish project, and coordination between the project and other studies. The Forage Fish Diets component (95163C) will provide information to the Forage Fish Assessment component (95163A) on the dietary overlap among forage fish species, which may provide insight into competition among forage fish. The Puffins as Samplers component (95163D) is linked to the Forage Fish Assessment component in that it may prove to be another method of sampling forage fish. The Forage Fish Assessment component will provide data on fish distribution, abundance, and composition to the Forage Fish Assessment/Birds component (95163B), the Pigeon Guillemot component (95163F), and the Kittiwake component (95163E).

The Forage Fish Assessment component and the Pigeon Guillemot and Kittiwake components will provide complementary and integral information to determine if food is limiting the recovery of seabird species. Data on seabird foraging and reproductive parameters will be compared to the forage fish assessment data to investigate the relationship of food availability or limitation to seabird productivity.

The Forage Fish Assessment component will also provide data on forage fish abundance, distribution, and availability to marine mammal studies (95001, 95064, 95117) to support marine mammal abundance and productivity model development.

The Forage Fish Assessment component will also be highly integrated with several components of the SEA Program and several of the seabird and marine mammal projects. The Physical Oceanography, Nearshore Fish, Zooplankton, and Phytoplankton components of SEA will collect data relevant to forage fish distribution and production. Within the SEA Physical Oceanography component, conductivity-temperature-depth (CTD) profilers and Acoustic Doppler Current Profilers (ADCP) will be deployed from a mid-water trawl vessel. Within the SEA Nearshore Fish component, hydroacoustic data will be obtained in offshore habitats from a mid-water trawl vessel and in nearshore habitats from small hydroacoustic survey boats. Within the SEA Zooplankton and Phytoplankton components, zooplankton and water samples will be collected using nets and water bottles. The Salmon Growth and Salmon Predation components of SEA will collect forage fish samples for later stomach contents analysis in offshore and nearshore habitats using mid-water trawls, and beach and purse seines. Age-weight-length data will be collected from the forage fish to accompany hydroacoustic data.

All data collected as part of SEA will be provided to the Information and Modeling component (95320J) and the Seabird/Forage Fish synthesis component (95163I) for use in development and implementation of ecosystem models.

FY 95 BUDGET ($K)

Personnel	42.8
Travel	6.0
Contractual	400.0
Commodities	1.0
Equipment	6.0
Subtotal	455.8
Gen. Admin.	26.9
Project Total	482.7

Forage Fish Assessment/Birds

Project Number:	95163B (formerly 95163)
Restoration Category:	Research (continuation of 94163)
Proposed By:	DOI
Cost FY 95:	$155,000
Cost FY 96:	$200,000
Total Cost:	Unknown
Duration:	6 years
Geographic Area:	Prince William Sound
Injured Resource/Service:	Picivorous birds

INTRODUCTION

Seabirds were severely impacted by the *Exxon Valdez* oil spill; 30,000 carcasses were recovered and estimates of losses exceed several hundred thousand. Three species (common murre, marbled murrelet, and pigeon guillemot) have not recovered from the population perturbation. In addition, recent black-legged kittiwake nesting failures may be linked to the spill. Pinnipeds within Prince William Sound (PWS) have also been declining. These declining species are picivorous. Avian species recovering from the spill forage on other foods. These data suggest that several picivorous species share a common food limitation.

NEED FOR THE PROJECT

Food limitation on seabirds can result from three possible changes in the forage resource:

1. A reduction in the total forage biomass.

2. A shift in the species composition of the forage resource resulting in lower food quality species becoming dominant.

3. Food is present in the ecosystem but no longer available to birds.

Each of these changes, or some combination of them, could have occurred in the spill area. A perturbation or other environmental change could have resulted in a decline in forage fish

recruitment that caused a decline in total biomass. It is also probable that a perturbation caused only some species of the forage fish guild to decline and others have responded to the availability of resources, freed by competitor declines, by increased recruitment. If forage fish guild composition shifts resulted in species of lower food quality becoming dominant, food may become limiting to predator species. A shift in forage fish guild composition could also result in dominance of species that spend most of their life history in water too deep for foraging birds, thereby causing food limitation. Of the proposed subprojects, this is the primary component to determine if food limitation has resulted from item 3, above.

PROJECT DESIGN

This project will be expanding upon established approaches and methods used to investigate forage fish/seabird interactions. Several similar investigations have been conducted at distant study sites (see papers by Schneider, Safina, Piatt, Obst, and Erikstad) as well as Alaska coastal areas (see papers by Piatt and Hunt). Improved data collection equipment, larger sample sizes, and temporal replication will result in a greater insight into forage fish/seabird interactions. The 1995 project will be an expansion of the 1994 project and will be developed in concert with the forage fish assessment subproject (95163A).

A. Objectives

This study will contribute to the objective of the Seabird /Forage Fish project: to determine if food limitation is preventing the recovery of injured seabirds. The overall objective of this subproject is to determine if food limitation is the result of unavailable food resources.

Specifically, the objectives are to determine the following:

1. What are the characteristics and distribution of foraging patches exploited by seabirds?

2. How abundant are foraging patches and what is the rate of their exploitation by seabirds?

3. How does the behavior of seabirds change with changes in food availability?

B. Methods

Seabird and marine mammal surveys will be conducted simultaneously with hydroacoustic surveys (hydroacoustic survey methods are described in proposal 95163A). Mammal and bird surveys will be conducted using standard techniques used previously in seabird and mammal population surveys in PWS. During hydroacoustic transects, all birds and mammals observed within 100 meters of the survey ship will be recorded. Categorical data will also be collected

on bird behavior. Times of observations will be recorded to allow direct comparison of hydroacoustic data to bird and mammal data.

Foraging patches will be defined as sites at which two or more birds are observed foraging. Hydroacoustics data will be used to determine species composition of foraging patches, water depth to patch, and size of patch. Hydroacoustics data will be further analyzed to determine the frequency of occurrence of patches suitable for bird foraging. The rate of exploitation of available forage patches will then be determined. Repeating the surveys for several years will provide data on how forage fish populations are changing and the behavioral responses of seabirds to changes in prey abundance by tracking the rate of forage patch exploitation and the distribution of birds.

C. Schedule

Because of budget constraints only two forage fish surveys and limited nearshore work will be conducted during 1995. Coordination will be made with the SEA project's Nearshore Fish component (95320N) to make up for data shortfalls.

April - July 1995	Coordinate with other studies for data collection
July - August 1995	Forage fish assessment cruises
July 1995 - January 1996	Analyze field data and prepare reports
31 January 1996	Draft report due
31 March 1996	Final report due

D. Technical Support

This project will generate data that will be important to other monitoring projects and studies being conducted in PWS. To facilitate access to project data, the information collected from this study will be incorporated into a data base managed by the Trustee Council and by SEA.

E. Location

This project will concentrate its initial activities within PWS. However in the future some sampling may be performed in the Gulf of Alaska, adjacent to PWS.

PROJECT IMPLEMENTATION

The U. S. Fish and Wildlife Service (USFWS) will obtain necessary data from the Forage Fish Assessment subproject (95163A) and will conduct all other phases of this study. The USFWS has demonstrated that it is the most appropriate entity to conduct this project through its previous monitoring and research on seabirds in PWS.

COORDINATION OF INTEGRATED RESEARCH EFFORT

This subproject is an integral part of the Seabird/Forage Fish project and will provide key information to the synthesis report. This component will be developed in close association with the contractor for the Forage Fish Assessment subproject (University of Alaska). Data collected will be used by the Puffins as Samplers (95163D), Kittiwakes as Indicators (95163E), and Pigeon Guillemot Recovery (95163F) subprojects. Coordination will be made with the SEA project's Juvenile Salmon and Herring Integration component (95320E) and Nearshore Fish (95320N) components to integrate data collection efforts.

FY 95 BUDGET ($K)

Personnel	117.00
Travel	8.0
Contractual	0.0
Commodities	0.0
Equipment	10.0
Subtotal	135.0
Gen. Admin.	20.0
Total	155.0

Competition and Prey of Forage Fish

Project Number:	95163C (was 95163)
Restoration Category:	Research
Proposed By:	ADF&G
Cooperating Agencies:	NOAA & DOI
Cost FY95:	$76,600
Cost FY96:	$76,600
Total Cost:	Unknown
Duration:	6 years minimum
Geographic Area:	Prince William Sound
Injured Resource/Service:	Multiple Resources

INTRODUCTION

A better understanding is needed of how prey availability affects distribution, abundance, growth, and reproductive success of apex predators. Efforts to restore predatory species affected by the oil spill, particularly harbor seals, pigeon guillemots, marbled murrelets, and black-legged kittiwakes, could be delayed or completely unsuccessful without understanding distribution, abundance, and availability of important forage fish. Factors controlling the life history of the forage fish, such as prey and competition, must also be understood.

NEED FOR THE PROJECT

This is a subproject of the Seabird/Forage Fish project (95163A-I), a multi-disciplinary project designed to understand the Prince William Sound food web and the associated effects on the injured species.

This subproject will concentrate on determining diet overlap and prey selection among forage fish species. This information, trophic position and niche overlap among species, will be used to establish the basic structure of future ecosystem models. The models of changing oceanographic regimes and prey species productivity, diet overlap and prey selection, and distribution are necessary for understanding recovery of predatory species, and useful in guiding recovery activities.

PROJECT DESIGN

The 1995 sampling program will be a continuation of the 1994 pilot project (94163) to determine diet overlap and prey selection among forage fish species. This project will also provide information on sex, age, growth, food habits, recruitment, and mortality of forage fish species.

A. Objective

Determine forage fish prey using stomach contents analysis for fish collected from nearshore and offshore sites, and estimate degree of diet overlap among species.

B. Methods

Forage fish will be sampled in nearshore and offshore areas using nets. Each species will be identified and length and weight measured on a minimum of 150 individuals randomly selected in each sample. Fifteen fish from each species will be preserved from each sample for later analysis of stomach contents.

C. Schedule

The forage fish surveys will be conducted under contract. The contractor work will conduct hydroacoustic and net sampling surveys during July and August. Additional samples will be collected by the Salmon Growth and Salmon Predation components of SEA (95320N) for later stomach contents analysis.

July - August 1995	Contractor net sampling
April - November 1995	SEA net sampling
June - 31 December 1995	Conduct stomach contents analysis
1 January - 31 March 1996	Analyze data and prepare annual report

D. Technical Support

This project will generate data that will be useful to the monitoring projects and studies currently underway in Prince William Sound. In order to insure access to these data, the information collected from this project will be incorporated into a data base managed by the Trustee Council (95089) and the SEA project (95320J).

E. Location

This project will concentrate its initial activities within Prince William Sound.

PROJECT IMPLEMENTATION

This project will be contracted and coordinated by ADF&G with cooperative components conducted by NOAA, USFWS, and SEA.

COORDINATION OF INTEGRATED RESEARCH EFFORT

This project will be highly integrated with several components of the Seabird/Forage Fish project, several components of the SEA project, and marine mammal projects. The Salmon Growth and Salmon Predation components of SEA will collect forage fish samples for later stomach contents analysis in offshore and nearshore habitats using mid-water trawls, and beach and purse seines. Age-weight-length data will be collected from the forage fish to accompany hydroacoustic data. All data collected as part of SEA will be provided to the Information and Modeling component 95320J for use in development and implementation of ecosystem models.

FY 95 BUDGET ($K)

Personnel	25.0
Travel	3.0
Contractual	40.0
Commodities	2.0
Equipment	0.0
Sub-total	70.0
Gen. Admin.	6.6
Project Total	76.6

Distribution and Abundance of Forage Fish as Indicated by Puffin Diet Sampling

Project Number:	95163D (formerly 95019)
Restoration Category:	Research (new)
Proposed By:	DOI
Cost FY95:	$32,250
Cost FY96:	$42,250 (includes $10,000 for analysis and write-up)
Total Cost:	Unknown
Duration:	6 years
Geographic Area:	Prince William Sound
Injured Resource/Service:	Multiple resources

INTRODUCTION

Tufted puffins are widely distributed in breeding colonies throughout the *Exxon Valdez* oil spill area. During the chick-rearing period, adults make several trips daily to the nest, carrying fresh prey to their young. By intercepting those food deliveries, it is possible to sample the nestling diet of puffins systematically and nonconsumptively. Puffins and other seabirds (murres, murrelets, guillemots, kittiwakes, and others) rely in summer on a food base consisting primarily of forage fish (capelin, sand lance, juvenile pollock, juvenile herring, myctophids, and others). This project will use puffin diet sampling as a means to quantify seasonal, annual, and geographic variation in the composition of the forage fish community at selected stations within the spill area. The project will complement traditional, more costly approaches involving hydroacoustics and net sampling and will also provide a reliable source of seabird prey specimens for laboratory analyses proposed in other projects.

NEED FOR THE PROJECT

Three species of seabirds (common murre, marbled murrelet, and pigeon guillemot) and one pinniped (harbor seal) were injured by the Exxon Valdez oil spill and are not recovering. An additional species (black-legged kittiwake) showed early effects on reproduction (comparing oiled and unoiled areas) and has experienced widespread breeding failure throughout Prince William Sound (PWS) in the last two years. The summer diets of these and other members of the pelagic community of vertebrate predators (birds, mammals, and fish) are known to

overlap. One hypothesis to explain the failure of recovery of injured species is that adverse changes are occurring in the quantity or quality of these species' prey. To test that hypothesis, it is necessary to quantify the status and trends of prey populations, particularly the forage fish that constitute an important part of the summer diet. Few data are available on the distribution and abundance of forage fish, because most species are not commercially harvested, and traditional methods of fishery science tend to be difficult and expensive. In the Gulf of Alaska, tufted puffins have proved to be excellent samplers of the forage fish community, providing annual indices of the distribution and relative abundances of keystone species such as capelin, sand lance, pollock, myctophids, and squids. Conducted over a span of years, this approach offers a cost-effective means of monitoring key components of the pelagic ecosystem and testing the hypothesis that recovery of seabirds and marine mammals is influenced by changes in the composition of marine fish stocks.

Seabirds in general, and puffins in particular, may constitute an important mortality factor on the early life stages of commercially important species. In the Gulf of Alaska, tufted puffins took 11 billion pollock from mid July to mid September in 1986, roughly one-tenth of the first-year juveniles available just prior to chick-rearing and ten times the number of fish surviving to the following March (Hatch and Sanger 1992). On the Barren Islands in 1993, puffins frequently delivered juvenile sockeye salmon, although the smolt were too large to be readily ingested by the chicks, and many went to waste (A. Kettle, pers. comm.).

Whether seabird predation proves to be a significant source of mortality or not, previous results suggest that diet sampling can provide an early indication of year-class strength in some species. For instance, the proportion of pollock in tufted puffin diets at the Semidi Islands (western Gulf of Alaska) was strongly correlated over three years with independent measures of year-class strength obtained in fishery investigations (Hatch and Sanger 1992). A similar outcome might be obtained for sockeye salmon at the Barren Islands or pink salmon in Hinchinbrook Entrance to PWS, where an out-migration of juveniles in late summer and fall (PWS Fisheries Research Planning Group, 1993) would encounter the sizeable puffin colonies on Porpoise Rocks and the Wooded Islands.

Because puffins deliver whole, undamaged prey to their chicks, this project can serve as a source of specimens for determination of prey quality (composition and energy density), population structure (age-sex ratios, genetic stock identification), and trophic studies (fish stomach contents, stable isotope ratios, and/or lipid analysis). Puffin samples have also been used to estimate daily growth increments of juvenile sand lance and pollock (Hatch 1984, Hatch and Sanger 1992).

PROJECT DESIGN

A. Objectives

1. Annually assess the species composition of the forage fish community near selected colonies of seabirds in the northern portion of the Exxon Valdez oil spill area.

2. Cross check the species composition of forage fish as determined by puffin diet sampling and hydroacoustic/net sampling techniques.

3. Assess the timing and magnitude of puffin predation on commercially important prey species including Pacific herring, pink salmon, and sockeye salmon.

4. Furnish whole prey specimens on demand for complementary studies of prey energetics, food web relationships, and fish population characteristics.

B. Methods

Puffin diet samples are collected most efficiently by placing wire screens over the entrances to burrows. Unable to enter, returning adults drop their food loads on or near the screens, which are removed when the samples are retrieved after 1-3 h. Samples are washed, bagged and preserved for later analysis in the laboratory. Any temporal sampling scheme desired can be implemented, but for maximizing the quantity of food obtained, morning hours are productive because puffins generally make a food delivery soon after first daylight.

One issue raised by this sampling approach is whether puffins take different types of prey in proportion to their relative abundances in the water column. Therefore, a desirable element of the field work during the first year of this project would be a comparison of the results from puffin diet sampling with simultaneous deployment of hydroacoustics and net sampling offshore at one or more colonies. The offshore work is not budgeted for in this proposal, but it is anticipated that the coordinated study would be achieved through cooperation with the Forage Fish Assessment subproject (95163A) and SEA components proposed for fiscal year 1995.

C. Schedule

November - June 1995	Recruit personnel, safety training, boat and collection equipment preparation.
June 1995	Reconnaissance of Naked Island group and vicinity for potential sampling sites.
July - August 1995	Field collection of puffin diet samples at Naked Island, Smith Island, or other locations in the core study area of the Seabird/Forage Fish project.
September 1995	Laboratory analysis of food samples.
October - December 1995	Complete laboratory analysis; data analysis and report writing.
January 1996	Draft annual report.
March 1996	Final annual report.

D. Technical Support

No technical support is required during the first year of study. An expanded program in the future may result in sufficient samples to warrant contracting for the identification and measurement of prey items.

E. Location

The intended sampling area during the first year of this project includes Naked Island and/or neighboring islands within the core study area delineated for the Seabird/Forage Fish project (95163A-I). There is a possibility that an insufficient number of puffins, or inaccessibility of their nesting habitat, could preclude the use of the proposed sampling techniques in this area. Thus, a minimum of equipment will be purchased initially, and a reconnaissance of potential sampling sites will be carried out in June, prior to first hatching of puffins. If a determination is made during the June reconnaissance that puffin diet sampling cannot be conducted safely and productively on Naked Island, Smith Island, or other nearby locations, the project will not be further implemented in 1995 and remaining funds will be returned to the EVOS Restoration Office for distribution to other projects.

PROJECT IMPLEMENTATION

This project will be implemented by the National Biological Survey, Alaska Science Center. Center personnel developed the field techniques proposed for puffin diet sampling and have successfully applied the method at more than 20 puffin colonies in the Gulf of Alaska since 1985.

COORDINATION OF INTEGRATED RESEARCH EFFORT

Coordination with offshore operations that sample forage fish by traditional methods is a recommended component of this project. The project will contribute to and draw upon SEA investigations of Juvenile Salmon and Herring Integration (95320), and will use information on physical oceanography generated by other EVOS funded studies in the interpretation of seasonal, annual, and geographic variation in forage fish communities.

PERSONNEL QUALIFICATIONS

Scott A. Hatch, Principal Investigator, is employed as a Supervisory Research Biologist in the Alaska Science Center, National Biological Survey. Dr. Hatch has conducted research on the population dynamics and feeding ecology of seabirds in Alaska since 1975. He has published more than 30 papers on those topics and has managed interagency programs for seabird research and monitoring since 1987. Curriculum vitae are filed and available on request from the Restoration Office, Exxon Valdez Oil Spill Trustee Council.

FY 95 BUDGET ($K)

Personnel	15.0
Travel	2.0
Contractual services	0.0
Commodities	2.0
Equipment	11.0
Subtotal	30.0
Gen. Admin.	2.3
Total	32.3

LITERATURE CITED

Hatch, S.A. 1984. Nestling diet and feeding rates of rhinoceros auklets in Alaska. Pp. 106-115 in D.N. Nettleship, G.A. Sanger, and P.F. Springer, eds. Marine birds: their feeding ecology and commercial fisheries relationships. Can. Wildl. Serv. Spec. Pub., Ottawa.

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

PWS Fisheries Research Planning Group. 1993. Sound ecosystem assessment: initial science plan and monitoring program. Rep. No. 1, Cordova, AK.

Kittiwakes as Indicators of Forage Fish Availability

Project Number:	95163E (formerly 95033)
Restoration Category:	Research (new)
Proposed By:	DOI
Cost FY 95:	$198 (includes data analysis and report writing costs)
Cost FY 96:	$198 (includes data analysis and report writing costs)
Total Cost:	$819,000
Duration:	Five years, depending on the frequency and duration of Seabird/Forage Fish project.
Geographic area:	Prince William Sound
Injured Resource/Service:	Multiple resources

INTRODUCTION

Populations of several species of marine birds and mammals that prey on forage fish have declined in Prince William Sound (PWS) since 1972; conversely, species that feed on benthic invertebrates have not declined. Marbled murrelets, pigeon guillemots, arctic terns, black-legged kittiwakes, glaucous-winged gulls, tufted puffins and harbor seals feed on schooling forage fish and have declined by more than 50%. Harlequin ducks, goldeneyes, black oystercatchers, and sea otters feed on benthic invertebrates and have not declined throughout PWS, although some species were affected by the *Exxon Valdez* oil spill. This pattern of declines in piscivorous species and the absence of declines in species consuming benthic invertebrates suggests that marked changes in the forage fish community distribution, abundance, or composition occurred over the last 20 years.

If populations of piscivorous marine birds and mammal populations that were injured by the *Exxon Valdez* oil spill (i.e., common murre, marbled murrelet, pigeon guillemot, and harbor seal) are currently limited by food, recovery of these populations is not likely. Therefore, an important question concerning the recovery of these injured species is, are their populations limited by food. The goal of this study is to evaluate the relative availability of forage fish for kittiwake populations in PWS, which were damaged by the oil spill and may serve as an indicator of other seabird species. This study, in collaboration with other components of the Seabird/Forage Fish project, will provide data to investigate the question; is food limiting?

The Trustee Council funded a kittiwake damage assessment study in 1990, which found that

reproductive success of kittiwakes was damaged by the oil spill. Prior to and after the spill the U.S. Fish and Wildlife Service (USFWS) monitored kittiwake population size and reproductive success in PWS. The USFWS study demonstrated that reproductive success of kittiwakes in PWS has not recovered since the spill. The USFWS monitoring also suggested that food availability to kittiwakes nesting in PWS has decreased. The USFWS monitoring will continue and the proposed study would complement the monitoring effort and provide stronger data to answer the question of food as a limiting factor.

NEED FOR THE PROJECT

The common murre, marbled murrelet, pigeon guillemot, and harbor seal are piscivorous injured species. A major question concerning the recovery of these injured species is; are their populations limited by food?

To answer this question, the best species to study are those that are widespread throughout PWS and for which data on foraging and breeding parameters can easily be collected. In PWS kittiwakes are well suited to address the food limitation question. There are 25 colonies spread throughout PWS, and because kittiwakes are colonial cliff-nesting birds, productivity and brood size can easily be obtained. Other breeding and feeding parameters are also inexpensive and easy to record. Also, there are ten years of population size and productivity data for kittiwakes in PWS that can be used for comparison.

Because kittiwakes prey on many of the same forage fish species as marbled murrelets, pigeon guillemots, and murres, they act as indicator species. However, because kittiwakes are surface feeders, a diving species such as pigeon guillemots should also be studied.

PROJECT DESIGN

A. Objectives

1. Determine relative food availability to kittiwakes by the following:

    a. Monitoring reproductive parameters such as egg laying date, clutch size, hatching success, growth rates, fledging success, brood size at fledging, and overall productivity.

    b. Monitoring diets and foraging parameters such as foraging trip length, foraging trip distance, foraging areas, chick provisioning rates, and species and size of prey consumed.

c. Monitoring survival rates of adults.

B. Methods

Twenty-four kittiwake colonies in PWS and three colonies in the northern Gulf of Alaska will be monitored for productivity and brood size at fledging. Clutch size will be monitored at 10 to 12 colonies in PWS. Hatching success, chick growth rates, fledging success, and diets will be monitored at four to six colonies in PWS. All parameters will be measured at two or three colonies in PWS.

Methods for measuring parameters are described by Irons. All methods have been used successfully in one or more other studies on kittiwakes. Productivity will be determined for entire colonies in PWS and study plots at colonies outside PWS. Productivity is measured by counting the numbers of nests in June, the number of pre-fledging chicks in August, and calculating an average number of chicks per nest. Egg laying dates, clutch sizes, hatching success, chick growth rates, provisioning rates and fledging success will be determined for nests in study plots at colonies. Foraging trip length will be measured using radio-tagged birds and data collection computers to monitor their foraging trips. Foraging trip distance and foraging areas will be determined by locating foraging radio-tagged birds with boats and planes in conjunction with the marbled murrelet project.

C. Schedule

October - May 1995	Prepare for field season
June - August 1995	Field work
August - November 1995	Contract for diet analysis
September - November 1995	Data analysis
December 1995 - January 1996	Report Writing
31 January 1996	Draft Report
31 March 1996	Final Report

D. Technical Support

This project will require technical support for analysis of diet samples and GIS mapping.

E. Location

Kittiwakes will be monitored throughout Prince William Sound at 24 kittiwake colonies in FY 95. In the future, this project will expand to include the oil spill zone of the northern Gulf of Alaska.

PROJECT IMPLEMENTATION

The USFWS will be the lead agency for this project. The USFWS has the technical expertise to conduct this study. Similar projects have been conducted by the USFWS on kittiwakes in PWS in the past. Successful methods have been established to collect and analyze data. The USFWS has trust responsibility for kittiwakes and all other seabirds as designated in the Migratory Bird Treaty Act of 1918.

COORDINATION OF INTEGRATED RESEARCH EFFORT

This is a subproject of the integrated Seabird/Forage Fish project (95163A-I) and will collaborate with other components to investigate whether food availability is limiting the recovery of injured species that prey on forage fish. There will be two major elements of coordination to ensure efficiency in this research program: coordination among the subprojects within the Seabird/Forage Fish project and coordination between the Seabird/Forage Fish project and other projects. Because of the links inherent in questions involving multiple trophic levels, the components of the Seabird/Forage Fish project are highly dependent upon each other. The Forage Fish Assessment component will provide data on fish distribution, abundance, and composition to the Kittiwakes as Indicators study. The Forage Fish Assessment/Bird component will provide data on foraging behavior in relation to fish distribution and abundance to the Kittiwake component. The Pigeon Guillemot and Kittiwake components will share information on the distribution of foraging birds and will compare their data to those of the Forage Fish Assessment/Bird component. Also, much data will be shared between the Seabird Energetics and the Kittiwake components.

Logistics will be coordinated to reduce cost and maximize data collection. The Pigeon Guillemot, Kittiwake, Puffin, and Seabird Energetics components will share field camps and logistical support where practical.

The Seabird/Forage Fish project will coordinate with several other projects in PWS to increase the overall efficiency of the *Exxon Valdez* Trustee Council work plan. All data collected by the Kittiwake subproject will be added to the data base management system that is maintained by the SEA program and to the oil spill office information management system. The Seabird/Forage Fish project program coordinator will ensure that coordination occurs in a timely, efficient manner.

FY 95 Budget ($K)

Personnel	106.9
Travel	6.0
Contractual Services	9.2
Commodities	15.0
Equipment	26.2
Subtotal	163.3
Gen. Admin.	16.7
Total	180.0

Factors Affecting the Recovery of Pigeon Guillemot Populations in Prince William Sound

Project Number:	95163F (formerly 95173)
Restoration Category:	Research (continuation of 94173)
Proposed By:	DOI
Cost FY 95:	$260,000
Cost FY 96:	$260,000
Total Cost:	Unknown
Duration:	5 to 10 years
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pigeon Guillemot

INTRODUCTION

The population of pigeon guillemots (*Cepphus columba*) in Prince William Sound (PWS) has decreased from about 15,000 in the 1970's (Isleib and Kessel 1973) to about 3,000 in 1993 (Sanger and Cody 1993). There is some evidence (Oakley and Kuletz 1993) suggesting that this population was in decline before the *Exxon Valdez* oil spill in March of 1989. An estimated 2,000 to 3,000 pigeon guillemots were killed throughout the spill zone immediately after the spill (Piatt et al. 1990). Based on censuses taken around the Naked Island complex (Naked, Peak, Storey, Smith, and Little Smith Islands), pre-spill counts (ca. 2,000 guillemots) were roughly twice as high as post-spill counts (ca. 1,000 guillemots; Oakley and Kuletz 1993). Also, relative declines in the numbers of guillemots were greater along oiled shorelines than along unoiled shorelines.

Adult guillemots delivered significantly fewer schooling fish, particularly sand lance (*Ammodytes hexapterus*), to their chicks after the spill (Oakley and Kuletz 1993). In 1994, sand lance accounted for about 1% of prey items fed to guillemot chicks at Jackpot Island and about 8% at Naked Island; by contrast, the sand lance component at Naked Island in 1979 was about 55% (Kuletz 1983). Gadids were much more prevalent in the diet of guillemot chicks on Naked Island in 1994 (ca. 30%) than they were in 1979-1981 (< 7%; Kuletz 1983). The apparent decline in the abundance of sand lance and change in relative proportions of other benthic and schooling fish in the diet of guillemot chicks might represent a key change in the PWS ecosystem that is affecting several species of marine birds and mammals that were injured by the spill.

Predation on eggs and chicks, not important previously (Oakley 1981), might have played a role in the lower reproductive success of guillemots after the spill (Oakley and Kuletz 1993). On Naked Island, nest predation was an important factor affecting the productivity of guillemots during the 1994 breeding season.

This study is a continuation of the Pigeon Guillemot Recovery Monitoring Project (94173), which began in 1994 and was funded by the Trustee Council. Also funded by the Trustee Council was an extensive survey of pigeon guillemot colonies in PWS (93034; Sanger and Cody 1993). Bird Study Number 9 (Oakley and Kuletz 1993), begun in 1989 immediately after the oil spill, compared various population and reproductive parameters of pigeon guillemots before (Oakley and Kuletz 1979; Kuletz 1981, 1983; Oakley 1981) and after the spill.

The goal of this study is to determine whether food, predation, toxicity from oil, or any combination of these is limiting the recovery of pigeon guillemot populations in PWS. The Forage Fish Assessment subproject (95163A) will provide information on the abundance, distribution, and species composition of forage fish in the study areas. In addition, specific information on the energy content and nutritional value of various forage fishes will be provided by the Seabird Energetics (95163G) and Forage Fish Composition (95163H) subprojects. The data gathered by the above components of the Seabird/Forage Fish project, in conjunction with our own studies of guillemot diet and foraging habits, will help us address the hypothesis that food is limiting recovery.

NEED FOR THE PROJECT

Considerable baseline data on pigeon guillemot populations and their foraging and reproductive ecology in PWS have been collected both before and after the oil spill. Continuation of these efforts is essential for monitoring any trends in the PWS populations and determining what factors are limiting their recovery. Food supply, predation, or oil toxicity might limit reproductive success. This project will attempt to evaluate the relative importance of each of these three factors.

Pre-spill studies of pigeon guillemots breeding at Naked Island suggest that sand lance are a preferred prey during chick-rearing (Kuletz 1983). Breeding pairs that specialized on sand lance tended to initiate nesting attempts earlier and produce chicks that grew faster and fledged at higher weights than breeding pairs that preyed mostly upon blennies and sculpins, at least in years when sand lance were readily available. Consequently, the overall productivity of the guillemot population was higher when sand lance were available. The post-spill decline in the prevalence of sand lance in the diet of guillemots breeding at Naked Island might be a key element in the failure of this species to recover from the oil spill. The schooling behavior of sand lance, coupled with their high lipid content relative to that of

gadids and nearshore bottom fish, might make this species a particularly high-quality forage resource for PWS pigeon guillemots. This is consistent with the observation that other seabird species (e.g., puffins, murres, kittiwakes) experience enhanced reproductive success when sand lance are available (Pearson 1968; Harris and Hislop 1978; Hunt et al. 1980; Vermeer 1979, 1980). This project, in conjunction with the Seabird Energetics subproject (95163G), will help assess the relative importance of sand lance and other forage fish resources for successful reproduction in PWS guillemots. There is a critical need for this information to understand the constraints that currently limit the recovery of seabirds and marine mammals damaged by the oil spill.

PROJECT DESIGN

A. Objectives

1. Determine if availability of food is limiting reproductive success of guillemots by collecting the following kinds of data:

    a. Measuring breeding parameters, including phenology, egg volume, chick growth rates, fledging weights, and reproductive success at colonies on Naked and Jackpot Islands.

    b. Measuring foraging parameters, including diet and provisioning rates of chicks, duration of foraging trips, and location of foraging areas.

    c. Obtaining independent data from the Forage Fish Assessment subproject (95163A) on the abundance of various forage fishes within the foraging areas used by guillemots during the chick-rearing period.

2. Determine if predation on eggs or chicks is limiting reproductive success by measuring relative rates of predation during the egg and chick stage in different habitats and at different colonies.

3. Determine if toxicity from petroleum hydrocarbon residues is limiting reproductive success by analyzing unhatched eggs and the carcasses of adults and chicks, and by analyzing blood samples from adults and chicks for biomarkers of stress associated with ingestion of petroleum hydrocarbons (in conjunction with project 95025C).

4. Determine if adult survival and recruitment are limiting the recovery of the guillemot population in PWS by resighting individually color-marked birds.

B. Methods

About 60 guillemot nests on Naked Island and 40 guillemot nests on Jackpot Island were located during the 1994 field season. Although not all of these were accessible to field personnel, they were monitored in some manner (e.g., for productivity and chick growth rates when possible, or at least provisioning rates if nests were inaccessible). These same two study sites will be used during the 1995 field season. We expect to find a few more accessible nests at Jackpot Island and several more at Naked Island during the next field season.

Reproductive success will be monitored using standard field techniques involving periodic nest checks. A portable, infrared-sensitive video camera system, specifically designed for inspecting dark burrows and holes, will be used to monitor those nests that cannot be checked by conventional means.

Morphometric data for determining growth rates will be acquired at regular intervals during the chick-rearing period. Provisioning rates and diets of chicks will be determined whenever possible throughout this period by observing them from strategically located blinds or from boats anchored offshore. Using VHF radio communications between observers in blinds and others in boats, attempts will be made to track guillemots to their foraging areas.

During the 1994 field season, we found conclusive evidence of predation on the eggs and chicks of guillemots on Naked Island. Strong evidence suggests that river otters (*Lutra canadensis*) were responsible for some of this predation. Other mustelids, such as mink (*Mustela vison*), might also be involved. There are conflicting reports as to whether mink are still present on Naked Island. Baited traps were used in 1994 in an unsuccessful attempt to document the presence of mink on the island. We will continue with this effort in 1995. Any evidence of predation will be collected or recorded. Also, time-lapse videography, or that triggered by infrared sensors, will be used in an attempt to document predation and identify predators, as well as to monitor activity budgets of chick-rearing guillemots.

An approved protocol will be used to collect unhatched eggs, which will be stored and shipped in sealed jars for hydrocarbon analysis.

Blood samples for biomarker analyses will be collected using standard protocols developed in collaboration with project 95025C (Bioindicators of Ecosystem Health: Guillemots and River Otters).

Estimates of adult survival will require the successful marking of birds (especially breeding adults, which are likely to return to the same nest each year) with unique color band combinations during the 1995 and future field seasons. In 1994, 80 birds were banded (19 adults and 61 chicks). Various methods of capturing adults (mist nets, noose mats, net traps

at the nest entrance, and by hand at the nest) were tried in 1994. Although almost all of these methods are quite labor-intensive, certain methods are more effective at particular phases of the breeding season. Thus, we should be able to band more adults next year if we plan our capture efforts accordingly. Because of the high degree of nest-site fidelity in pigeon guillemots, known breeding birds not sighted the following season will be assumed to be dead. Marked birds are also useful in determining sex, activity budgets, and reproductive histories of individual birds.

C. Schedule

October - December 1994	Data analysis
December - January 1995	Report writing
31 January 1995	Draft report
31 March 1995	Final report
May - August 1995	Field work/data collection
September - November 1995	Data analysis
December - January 1996	Report writing
31 January 1996	Draft report
31 March 1996	Final report

D. Technical Support

Hydrocarbon analyses of unhatched eggs will be subcontracted to Texas A&M University.

E. Location

Most, if not all, of our work in 1995 will be concentrated on Naked Island and Jackpot Island. Naked Island is ideal for studying pigeon guillemots for the following reasons: 1) Naked and nearby islands (Peak, Storey, Smith, and Little Smith) support approximately one fourth of the guillemots in PWS; 2) there are many previously identified, accessible nest sites on the island; 3) there are excellent baseline data on the island's guillemot population that were obtained both before and after the oil spill, and finally; 4) Cabin Bay provides a suitable field camp site and an excellent anchorage for our boats. Jackpot Island was first used as a study site for pigeon guillemots in 1994. Its small size and numerous accessible nests make it an excellent study site. In 1994, a considerable effort was made to find other guillemot study sites in PWS, but these two islands are the only ones that met our criteria: large numbers of guillemots and accessible nest sites.

PROJECT IMPLEMENTATION

The U. S. Fish and Wildlife Service has the appropriate expertise to conduct the monitoring project outlined above. This agency employs several people with extensive experience in studying the breeding biology and feeding ecology of guillemots. The transport of field equipment from Whittier to Naked Island by barge and the hydrocarbon analyses will be subcontracted.

COORDINATION OF INTEGRATED RESEARCH EFFORT

This proposed study is a component or subproject of the larger Seabird/Forage Fish project (95163A-I). The Forage Fish Assessment subproject (95163A) will provide the Pigeon Guillemot Recovery component with data on fish distribution, abundance, and species composition, while the Forage Fish Assessment/Birds subproject (95163B) will provide pertinent data on the foraging behavior of guillemots in relation to the distribution and abundance of forage fish. At the guillemot study sites (Naked and Jackpot Islands), personnel from the Pigeon Guillemot Recovery subproject (95163F) will work closely with those of the Seabird Energetics subproject (95163G). Because of the difficulty in finding accessible nests, it is imperative that the Seabird Energetics component have access to most of the pigeon guillemot nest sites that were located and used during the 1994 field season. The Principal Investigators (D. Lindsey Hayes, 95163F; Dr. Dan Roby, 95163G) of these two components have agreed to share access to most of these nests. In addition, they are coordinating their efforts so that the kinds of data and measurements needed by each component are collected only once, and in the same manner. This might involve a division of labor (and possibly nest sites, or even study sites) between the two subprojects and subsequent sharing of the data, or perhaps having members from each field crew present during each nest check. Dr. Roby is also one of the Principal Investigators on the Bioindicators project (95025C), and in support of that project, we expect to help him obtain blood samples from guillemot adults and chicks during our routine nest checks.

The Puffins as Samplers subproject (95163D) and the Marbled Murrelet project (95031) might have field camps on Naked Island during the 1995 field season. The Seabird Energetics subproject (95163G) will be based either at Naked Island or in the vicinity of Jackpot Island. Any of these studies that are based at Naked Island will share transport costs. The Eleanor Island component of the Kittiwakes as Indicators subproject (95163G) will share costs for the delivery of their fuel caches. Also, combining field camps will make communications between various groups and their respective offices easier and obviate the need for each group to purchase its own radio and antenna. Increased numbers of personnel at a given location can sometimes enhance the collection of data, such as opportunistic observations of rare events that might be pertinent to a particular study.

FY 95 BUDGET ($K)

Personnel	151.0
Travel	11.0
Contractual	30.0
Commodities	15.0
Equipment	28.3
Subtotal	242.0
Gen. Admin.	24.7
Total	260.0

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Diet Composition, Reproductive Energetics, and Productivity of Seabirds Damaged by the *Exxon Valdez* Oil Spill

Project Number:	95163G (formerly 95118-BAA)
Restoration Category:	Research (new)
Proposed By:	University of Alaska Fairbanks
Lead Trustee Agency:	NOAA
Cost FY 95:	$140,600
Cost FY 96:	$144,100
Total Cost:	Unknown
Duration:	5 years (useful results can be obtained in 3 years, but to be effective the project should be supported a minimum of 4 years)
Geographic Area:	Prince William Sound (Naked Island, Shoup Bay, Eleanor Island, Jackpot Island, Icy Bay)
Injured Resource/Service:	Multiple resources

INTRODUCTION

Three seabird species that were damaged by the *Exxon Valdez* oil spill (EVOS) are failing to recover at an acceptable rate: pigeon guillemot (*Cepphus columba*), common murre (*Uria aalge*), and marbled murrelet (*Brachyramphus marmoratus*). Damage from the spill to a fourth species of seabird, black-legged kittiwake, is equivocal, but recent reproductive failures of kittiwakes within the spill area may be due to longer term ecosystem perturbation related to the spill (D. Irons, pers. comm.). The status of pigeon guillemots and marbled murrelets in Prince William Sound (PWS) and the Northern Gulf of Alaska has been of concern for nearly a decade due to declines in numbers of adults observed on survey routes (Laing and Klosiewski 1993).

The failure of these seabirds to recover has been attributed to low reproductive success, but there is a troubling lack of information on the factors ultimately responsible for low productivity. One prevalent hypothesis is that changes in the abundance and species composition of forage fish resources within the spill area has resulted in food provisioning rates that are below the requirements of growing nestlings. Concurrent population declines in some marine mammals, particularly harbor seals, have also been blamed on food limitations.

Whether these changes in forage fish availability are related to or have been exacerbated by EVOS is unknown.

Reproductive success in seabirds is largely dependent on foraging constraints experienced by breeding adults. Previous studies on the reproductive energetics of seabirds have indicated that productivity is energy-limited, particularly during brood-rearing (Roby 1991a). Also, the young of most seabird species accumulate substantial fat stores prior to fledging, an energy reserve that is crucial for post-fledging survival. Data on foraging habitats, prey availability, and diet composition are critical for understanding the effects of changes in the distribution and abundance of forage fish resources on the productivity and dynamics of seabird populations.

The composition of forage fish is particularly relevant to reproductive success because it is the primary determinant of the energy density of chick diets. Parent seabirds that transport chick meals in their stomachs (e.g., kittiwakes) or in a specialized pouch (e.g., auklets) normally transport meals that are close to the maximum load. Seabirds that transport chick meals as single prey items held in the bill (e.g., guillemots, murres, murrelets) experience additional constraints on meal size if optimal-sized prey are not readily available. Consequently, seabird parents that provision their young with fish high in lipids are able to support faster growing chicks that fledge earlier and with larger fat reserves. This is because the energy density of lipid is approximately twice that of protein and carbohydrate. Also, most of the nonlipid dry matter in fish consists of protein, and metabolism of protein as an energy source requires the energetically expensive process of excreting the resultant nitrogenous waste. While breeding adults can afford to consume prey that are low quality (i.e., low in lipid) but abundant, reproductive success is largely dependent on provisioning young with high quality food items. If prey of adequate quality to support normal nestling growth and development are not available, nestlings either starve in the nest or prolong the nestling period and fledge with low fat reserves.

Forage fish vary considerably in lipid content, lipid:protein ratio, energy density, and nutritional quality. Much of the energy content of prey consumed by seabirds is in the form of neutral lipids, especially triglycerides and wax esters, and wax esters in particular are known to be difficult to digest (Nevenzel 1970; Lee et al. 1972; Benson et al. 1972; Sargent 1976; Clarke 1984, In press). In some seabird prey, such as lanternfishes (Myctophidae), lipids may constitute as much as 50% of dry mass (A. R. Place, unpubl. data); while in other prey, such as juvenile walleye pollock (*Theragra chalcogramma*), lipids are less than 5% of dry mass (J. Wejak, unpubl. data). This means that a given mass of lanternfish has more than twice the energy content of the same mass of juvenile pollock. Published values for lipid content (% dry mass) of other forage fish are intermediate between those of lanternfish and juvenile pollock: herring (Clupeidae)- 36.7%, sand lance (Ammodytidae) - 24.4%, smelt (Osmeridae) - 15.8%, capelin (*Mallotus villosus*) - 15.3% (Montevecchi et al. 1984, Barrett et al. 1987, Massias and Becker 1990). These studies have shown that for a particular species

of forage fish, lipid content can vary widely with season, sex, reproductive status, and age class. For example, sand lance can vary from 10% lipid (% dry mass) to 31.5% lipid (Hislop et al. 1991) and gravid female capelin have nearly twice the energy density of male capelin (Montevecchi and Piatt 1984). By increasing the proportion of high-lipid fish in chick diets, parents can increase the energy density of chick meals in order to compensate for the low frequency of chick feeding (Ricklefs 1984a, Ricklefs et al. 1985).

NEED FOR THE PROJECT

This study is relevant to the Seabird/Forage Fish project (95163A-I) and EVOS Restoration Work because it is designed to develop a better understanding of how shifts in the diet of seabirds breeding in PWS affect reproductive success. Unlike marine mammals, seabirds offer the possibility of directly measuring diet composition and feeding rates, and their relation to productivity. By monitoring the composition and provisioning rates of seabird nestling diets, prey preferences can be assessed. Measuring provisioning rates is crucial because even very poor quality prey may constitute an acceptable diet if it can be supplied at a high rate. Understanding the diet composition, foraging niche, and energetic constraints on seabirds breeding within the spill area will be crucial for designing management initiatives to enhance productivity in species that are failing to recover from EVOS. If forage fish that are high in lipids are an essential resource for successful reproduction, then efforts can be focused on assessing stocks of preferred forage fish and the factors that impinge on the availability of these resources within foraging distance of breeding colonies in PWS. As long as the significance of diet composition is not understood, it will be difficult to interpret shifts in the utilization of forage fishes and develop a management plan for effective recovery of damaged species.

There is a definite need for information on the relationship between diet and reproductive success for pigeon guillemots, common murres, and marbled murrelets, all seabird species that are failing to recover from EVOS at an acceptable rate. However, the latter two species pose serious problems for studies of diet composition in the spill area. For common murres it is difficult to collect quantitative data on diet composition, feeding rate, meal size, and chick growth rates without seriously impacting productivity because this species nests in dense colonies on narrow ledges where human activity can cause high losses of eggs and chicks. Also, murre chicks leave the nest site to go to sea at only c. 21 days post-hatch, when they are only 20% of adult mass. In addition, the murre colonies most damaged by the spill and slowest to recover are located in the Barren Islands, where few nesting ledges are accessible. Marbled murrelet nests are usually located high in mature conifers and are very difficult to locate. Most nest visits by parents provisioning young occur at night, so monitoring chick diets is highly problematic. While some limited information on chick diets may be obtained as part of on-going EVOS studies of common murres in the Barren Islands (project 95039, "Common Murre Productivity Monitoring") and marbled murrelets breeding on Naked Island

(project 95031, "Reproductive Success as a Factor Affecting Recovery of Murrelets in PWS"), neither of these species are feasible study subjects for assessing the role of diet composition for seabird reproductive success in the spill area. Consequently, the Principal Investigators (PIs) in the Seabird/Forage Fish project have agreed to focus their efforts on pigeon guillemots and black-legged kittiwakes nesting in PWS.

Guillemots are the most neritic members of the seabird family Alcidae (i.e., murres, puffins, and auks), and like the other members of the family, capture prey during pursuit-dives. Pigeon guillemots are a well-suited species for monitoring forage fish availability for several reasons: (1) they are a common and widespread seabird species breeding in PWS (Sowls et al. 1978); (2) they primarily forage within 5 km of the nest site (Drent 1965); (3) unlike most seabird species, they do not breed in large, dense colonies; (4) they raise their young almost entirely on fish; (5) they prey on a wide variety of fishes, including schooling forage fish (e.g., sand lance, herring, smelt) and subtidal/nearshore bottom fish (blennies, sculpins; Drent 1965, Kuletz 1983); (6) the one- or two-chick broods are fed in the nest until the young reach adult body size. In addition, there is some evidence that many guillemot pairs breeding at Naked Island before the spill specialized on schooling forage fish, particularly sand lance, during the chick-rearing period. Reproductive success of these pairs was lower when sand lance was less available (Kuletz 1983). Guillemots carry whole fish in their bills to the nest-site to feed their young. Thus individual prey items can be identified, weighed, measured, and collected for composition analyses.

Black-legged kittiwakes also breed abundantly in the spill area and rely largely on forage fish during reproduction. Unlike guillemots, kittiwakes are efficient fliers, forage at considerable distances from the nest, and capture prey at or near the surface. Although kittiwakes are highly colonial, cliff-nesting seabirds, they construct nests and can be readily studied at the breeding colony without causing substantial egg loss and chick mortality. Several breeding colonies of black-legged kittiwakes in PWS are easily accessible so that chicks can be weighed regularly without resorting to technical climbing (D. Irons, pers. comm.). Diets fed to kittiwake chicks in PWS consist primarily of schooling forage fish (i.e., sand lance, herring, juvenile walleye pollock), but when forage fish are scarce, euphausiids may be substituted. Like guillemots, kittiwakes can raise one- or two-chick broods, and chicks remain in the nest until nearly adult size. Together with pigeon guillemots, black-legged kittiwakes are excellent bioindicators of the distribution and abundance of preferred forage fish in PWS.

The proposed research is the first focused study to investigate the effects of diet composition on reproductive energetics and productivity of piscivorous seabirds in PWS. The research will result in a fundamental advance in our understanding of the significance of prey composition for pigeon guillemot and black-legged kittiwake reproduction, as well as for other seabirds and marine mammals that breed in PWS. The research will also provide new information relevant to several additional areas of study: (1) comparative biochemical

composition and physiological condition of forage fishes, (2) factors such as age class, sex, size, and reproductive status as they influence the nutritional quality of forage fishes, (3) responses of breeding seabirds to shifts in prey availability, and (4) the energetic consequences of foraging on different prey with differing energy content. This research will be the first to (1) measure the nutritional quality of various forage fishes used by breeding seabirds in PWS, (2) use data on diet composition and provisioning rates to construct energetics models of chick growth and survival, and (3) monitor fat deposition rates of individual seabird chicks on differing dietary regimes by repeated, noninvasive analysis. In addition, the results will have broader implications for our understanding of dietary constraints on reproductive success in other piscivorous seabirds damaged by the spill (common murre, marbled murrelet) and will enhance our understanding of the adaptive significance of prey preferences in these seabirds. These results are crucial for understanding the factors constraining recovery of seabirds and marine mammals damaged by the spill.

PROJECT DESIGN

A. Objectives

The overall objective of the proposed research is to determine the energy content and nutritional value of various forage fishes used by seabirds breeding in the EVOS area, and to relate differences in prey quality and availability to reproductive success and physiological condition of breeding adults. The proposed research will emphasize pigeon guillemots and black-legged kittiwakes for practical reasons, but prey composition and quality will be evaluated for common murres, marbled murrelets, and tufted puffins as data and samples permit. Specific objectives are enumerated below:

1. To determine the nutritional quality of various forage fish species consumed by seabirds in the EVOS area as a function of size, sex, age class, and reproductive status, including:
   a. lipid content
   b. water content
   c. ash-free lean dry matter (protein) content
   d. energy density (kJ/g fresh mass)
   e. lipid composition (triglyceride, wax ester, mono- and diglyceride, free fatty acid, phospholipid)

2. To determine dietary parameters of pigeon guillemot and black-legged kittiwake chicks in PWS, including:
   a. provisioning rate (meal size X delivery rate)
   b. taxonomic composition of the diet
   c. biochemical composition of the diet

d. energy density of the diet

3. To determine the relationship between diet and the growth, development, and survival of seabird nestlings. Variables measured will include:
   a. growth rates of total body mass, lean body mass, and total body fat
   b. rates and patterns of flight feather development
   c. fledgling body mass and fat reserves
   d. fledging age

4. To determine the contribution of specific forage fish resources to the overall productivity of seabird breeding pairs, including:
   a. body composition (physiological condition) of parents raising chicks
   a. gross foraging efficiency of parents
   b. conversion efficiency of food to biomass in chicks
   c. net production efficiency of the parent/offspring unit

B. Methods

The proposed research approach utilizes a combination of sample/data collection in the field (in conjunction with other Seabird/Forage Fish subprojects in PWS) and laboratory analyses. Sample collection and field data collection will be conducted concurrently during the 1995-1998 breeding seasons at two guillemot and two kittiwake colonies in PWS. A minimum of 50 active and accessible nests of each species will be located and marked prior to hatching at each of the study colonies during the four breeding seasons. These nests will be closely-monitored until the young fledge or the nesting attempt fails.

Fresh samples of forage fishes used by guillemots will be collected for proximate analysis using three techniques: (1) temporarily placing "neckties" on guillemot chicks to prevent them from swallowing prey delivered by parents and retrieving samples from chicks, (2) temporarily placing obstructions in the entrance of guillemot nest crevices immediately after arrival of an adult with a chick meal and retrieving samples from adults, and (3) capturing adults carrying forage fish in noose traps as they approach the nest and retrieving samples from adults. Supplemental samples of guillemot forage fishes will be collected using minnow traps deployed in guillemot foraging areas and netting specimens at low tide. Kittiwakes transport chick meals in the stomach and esophagus, so chick diet samples will consist of semi-digested food. Kittiwake meal samples are normally collected when chicks regurgitate during routine weighing and measuring. Fresh specimens of forage fishes used by kittiwakes will be provided from at-sea trawls conducted as part of the Seabird/Forage Fish subproject 95163A, "Abundance and Distribution of Forage Fish and their Influence on Recovery of Injured Species." Fresh fish samples and kittiwake regurgitations will be weighed (± 0.1 g) in the field and immediately frozen in small, propane-powered freezers that will be maintained at each of the four study sites. Samples will be shipped frozen to my laboratory

at the University of Alaska Fairbanks, where they will be kept in an ultra-low freezer at -70°C until proximate analysis. In the lab, forage fish specimens will be reweighed (± 0.1 mg), identified to species, aged, sexed, measured, and reproductive status (gravid, recently spawned, nonreproductive) determined. Kittiwake regurgitations will be sorted into prey classes to the extent feasible, but otherwise handled as with fresh prey samples. Forage fish specimens will be dried to constant mass in a convection oven at 60°C to determine water content. Lipid content of a subsample of dried forage fish will be determined by solvent extraction using a soxhlet apparatus and petroleum ether as the solvent system. Lean dry fish samples will then be ashed in a muffle furnace at 550°C in order to calculate ash-free lean dry mass by subtraction. A subsample of dried forage fish samples will be combusted in a bomb calorimeter to determine energy density. Energy content of chick diets will be calculated from both the energy densities determined by bomb calorimetry and the composition (water, lipid, lipid-free dry matter, and ash) of forage fish along with published energy equivalents of these fractions (Roby 1991).

The lipid composition of forage fish (percentage wax esters, triglycerides, mono- and diglycerides, free fatty acids, and phospholipids of total lipids) will be determined by extracting total lipids from a subsample of fresh-frozen forage fish using the Bligh and Dyer (1959) technique. Extracted lipids will then be separated into the various lipid classes and quantitated using TLC/FID analysis procedures on a Mark IV Iatroscan. This procedure will allow us to determine the percentage of total lipids in forage fish that are in the form of wax esters and other refractory (hard to digest) lipid classes (Roby et al. 1986). My laboratory is equipped with all the instrumentation required for proximate analysis of samples, including a Soxtec HT-12 soxhlet apparatus; an Iatroscan TLC/FID system; and a Parr automated adiabatic bomb calorimeter.

Chick provisioning rates for pigeon guillemots and black-legged kittiwakes in PWS will be determined by monitoring active nests to determine meal delivery rates throughout the 24 h period. Average meal size, taxonomic and biochemical composition of the diet, and average energy density of chick meals will be determined as part of analyses of diet samples collected from guillemot and kittiwake chicks.

Known-age chicks will be weighed and measured regularly to determine individual growth rates throughout the nestling period. Total body fat of chicks at 20 and 30 days post-hatch will be determined by noninvasive (nondestructive) measurement of total body electrical conductivity (Walsberg 1988, Roby 1991). Fat reserves of chicks will be measured in the field using total body electrical conductivity (TOBEC) fat analyzers (SA-3000 Small Animal Body Composition Analyzer from EM-SCAN, Inc., Springfield, IL) that I currently have in my lab. The TOBEC method relies on the major difference in conductivity between lipids and other body constituents to estimate total lean body mass (Pethig 1979; Van Loan and Mayclin 1987). The difference between total body mass, as determined by weighing, and lean body mass, estimated by TOBEC, provides an estimate of total body fat. A major

advantage of the technique is that measurements can be obtained rapidly and repeatedly without harm to the subject. Also, validation studies to date indicate that accuracy is high (r^2 = .996) (Bracco et al. 1983, Walsberg 1988, Roby 1991b). The SA-3000 TOBEC analyzer can be used in the field and powered from a 12 volt battery, so chicks can be measured for TOBEC and returned to their nest in a matter of minutes. Body mass, primary feather development, and total body fat measurements will be used to develop a condition index for each chick at 20 and 30 days post-hatch.

The effects of diet composition on the physiological condition of breeding adults will be monitored using a combination of direct and indirect methods. Attentiveness of adults will be monitored during the incubation period. Adults will be captured on the nest early in the chick-rearing period and body composition determined nondestructively by TOBEC analysis. Frequency of chick meal delivery and meal size will be determined during the chick-rearing period as part of diet composition studies.

Data on chick age-specific body mass, wing chord, and primary feather length will be separated by year and colony for each species, and fit to Gompertz sigmoidal growth models. Growth constants (K), inflection points (I), and asymptotes (A) of fitted curves will be statistically analyzed for significant differences among years and colonies. Lipid deposition rates from TOBEC analysis will be compared using slopes of least squares linear regression models. Gross foraging efficiency of adults will be calculated from daily energy expenditure by the following equation:

$$([M \cdot F \cdot D] + DEE) / DEE = GFE,$$

where M is average chick meal mass in grams, F is average frequency of meal delivery in meals day^{-1} $parent^{-1}$, D is energy density of chick meals in kJ/gram, DEE is adult daily energy expenditure in kJ/day, and GFE is adult gross foraging efficiency in kJ consumed/kJ expended. Daily energy expenditures of pigeon guillemots, black-legged kittiwakes, and common murres have been measured previously using the doubly-labeled water technique and are available in the published literature (Birt-Friesen et al. 1990). Net production efficiency of chicks as a function of age will be calculated by regressing the change in body mass over a 24 hour period against the mass of food consumed during the period, as determined by periodic weighing. Comparison of food conversion efficiency of chicks will provide an estimate of the relative energetic efficiency of diets composed of various forage fishes. The net production efficiency of the parent/offspring unit will be calculated for each diet and each year for both species using the equation:

$$CFCE / ([DEE \cdot 2] + [M \cdot F \cdot D]) = TNPE,$$

where CFCE is chick food conversion efficiency in grams of body mass gained per gram food ingested, TNPE is the total net production efficiency of the parent/offspring unit in grams gained by chicks per kJ of energy expended by both parents, and other variables are as described above.

C. Schedule

Field work in PWS will be conducted during the 1995, 1996, 1997, and 1998 breeding seasons. Data collection during four field seasons will be necessary in order to provide minimal information on interannual variation in diet composition and reproductive success. Guillemots and kittiwakes normally lay eggs from late May to late June and raise their young during July and August. Field crews will be set up at each of the four colonies in mid-May. Active, accessible nests of the two study species will be located and marked during late May and June, prior to hatching. Marked nests will be checked daily during the hatching period to determine hatching date, and, in the case of two-chick broods, chicks will be banded soon after hatching so that individual growth rates can be monitored throughout the nestling period. Samples of chick meals and measurements of chick feeding rates will be collected throughout the nestling period. Chicks will be monitored throughout the nestling period in order to determine growth rates, fledgling mass, fledging age, and survival until fledging.

Following the field season, chick meals will be analyzed in the lab in order to determine the taxonomic and biochemical composition of guillemot and kittiwake diets and their relationship to chick growth and survival. These analyses will be completed before the next field season in order to determine the results prior to collecting additional samples from the field. A draft annual report for this subproject will be prepared in February and a final report will be submitted in March for incorporation into a synthesis Annual Report for the Seabird/Forage Fish project in June.

Following the analysis of samples collected during the 1998 field season, data collected during the three field seasons will be analyzed for relationships between diet composition and reproductive success by May 1999. The results of these analyses of diet composition and its relation to productivity and chick growth will be prepared in manuscript form and submitted by the end of FY 1999.

D. Technical Support

Laboratory analyses of the biochemical composition and energy content of forage fishes will be conducted in the laboratory of the PI. No analyses will be subcontracted to other laboratories. No new laboratory equipment will need to be purchased for the proposed research with funds provided by the grant. A laboratory technician will be hired to help the PI and graduate research assistant with processing chick meals and diet samples, and with performing of routine laboratory analyses.

E. Location

The proposed field work will be conducted in PWS during FY 1995, with possible expansion to adjacent parts of the oil spill area in subsequent field seasons. PWS supports accessible

breeding populations of guillemots and kittiwakes that are more than adequate for the proposed research. Field work on guillemots will be conducted at breeding colonies on Naked Island and Jackpot Island. Naked Island is surrounded by a broad shallow shelf, whereas Jackpot Island is in deep water. Consequently, the foraging habitats available within foraging distance of the two colonies are markedly different.

Approximately 500 pigeon guillemots nest along the shores of Naked Isla nd (Sanger and Cody 1993), as well as smaller numbers of marbled murrelets and tufted puffins. The Naked Island base camp would offer an ideal base for field studies on guillemots (D. Irons, pers. comm.), and Naked Island supports the highest breeding densities of guillemots in PWS (Sanger and Cody 1993). In addition, Naked Island has been the site of long term studies since the early 1980s by the U.S. Fish and Wildlife Service (USFWS) on factors affecting reproductive success of pigeon guillemots in PWS (Kuletz 1983). Jackpot Island supports about 50 breeding pairs of guillemots that are nesting at extremely high densities and in unusually accessible nests (G. Sanger, D. L. Hayes, pers. comm.). Additional guillemot nests will be located and monitored adjacent to Jackpot Island in Icy Bay. Both Naked Island and Jackpot Island were the site of intensive studies of guillemot nesting success during the 1994 field season and have been selected for continued studies (BPD 95163F) as part of the Seabirds/Forage Fish project (D. L. Hayes, pers. comm.).

Field work on kittiwakes in PWS will be conducted at two breeding colonies, one at Shoup Bay (off Valdez Arm) which supports approximately 400 breeding pairs of black-legged kittiwakes and another at Eleanor Island (adjacent to Naked Island) which supports about 550 breeding pairs. The Shoup Bay colony is the site of continuing long-term studies of kittiwake nesting ecology in PWS by the USFWS and Eleanor Island has been selected as a site for intensive study for comparison purposes (D. Irons, pers. comm.). Both colonies include large numbers of readily accessible nests.

The at-sea foraging distribution of pigeon guillemots near Naked Island and Jackpot Island has been the subject of previous study (Sanger and Cody 1993), as has the species composition of the diet (Kuletz 1983). Kittiwake foraging distribution and reproductive success has been monitored at the Shoup Bay colony for several years (D. Irons, pers. comm.). In addition, subproject 95163B will provide data on the distribution of foraging kittiwakes and guillemots in the vicinity of the four study colonies during the chick-rearing period. A field camp operated by the USFWS is available for field workers on Naked Island and at Shoup Bay and is within walking distance or short boat ride of colonies where adequate numbers of accessible guillemot and kittiwake nests are available.

PROJECT IMPLEMENTATION

The proposed research will be implemented by the University of Alaska Fairbanks, closely

coordinated with and in cooperation with USFWS biologists with expertise on the proposed study species in the proposed study area. The PI (Daniel D. Roby) has extensive experience with studies of the reproductive energetics of high latitude seabirds and the relationship between diet composition and productivity. The PI currently has in his laboratory the analytical equipment necessary to accomplish the proposed laboratory analyses and is familiar with the relevant analytical procedures. To the PI's knowledge, the expertise and equipment necessary for the proposed research are not available within the federal and state agencies that compose the Trustees Council. The PI will be assisted by a Graduate Research Assistant (Ph.D. candidate), Field Technician, and undergraduate field assistant who will be carefully selected from the applicant pool as qualified to participate in the proposed research.

COORDINATION OF INTEGRATED RESEARCH EFFORT

The research described in this proposal is a subproject within the Seabird/Forage Fish project (95163A-I) and dove-tails nicely with new and continuing research to assess factors limiting recovery of seabird populations damaged by EVOS. It is also relevant to efforts toward developing seabird models as upper trophic level sentinels of changes in the availability of forage fish, such as sand lance, juvenile pollock, herring, capelin, and smelt. The proposed research approach utilizes prey composition, reproduction rates, and energetics models to help identify and quantify the present level of forage fish availability within the PWS ecosystem. This approach is necessary because evaluation of the stocks of various forage fishes is extremely complex due to temporal and spatial variability and unpredictability in the distribution of forage fish in PWS.

Studies of foraging, reproduction, and population recovery following the EVOS are on-going for pigeon guillemots, common murres, and marbled murrelets. Black-legged kittiwakes are currently being used as indicators of ecosystem function and health within PWS. This proposal complements and enhances other proposed studies on pigeon guillemots and black-legged kittiwakes without duplication of effort. The PI on the present proposal has been and will continue to work closely with Dr. David Irons (PI on subproject 95163E [formerly 95033] "Kittiwakes as Indicators of Forage Fish Availability) and D. Lindsey Hayes (PI on subproject 95163F [formerly 95173] "Factors Affecting Recovery of PWS Pigeon Guillemot Populations") in developing protocols for collecting field data on kittiwakes and guillemots so as to minimize project cost and maximize data acquisition. Dr. Irons and Mr. Hayes are both with the Migratory Bird Branch, USFWS. Dr. Irons has had extensive experience working in the field with both guillemots and kittiwakes nesting in PWS, and is project leader for on-going studies of the reproductive success and status of these two species in PWS. Mr. Hayes was in charge of the field crew working on pigeon guillemots at Naked Island during the 1994 breeding season and has extensive field experience with nesting guillemots. Close coordination with Dr. Irons' and Mr. Hayes' research teams will be essential for the success of the proposed research.

Subprojects 95163E, 95163F, and the present subproject (95163G) all require information on chick feeding rates, chick meal size, and taxonomic composition of chick diets in order to meet their objectives. Collecting these data is extremely labor intensive and the cooperation of these three subprojects in collecting these data will greatly enhance sample sizes. The three subprojects also require data on chick growth rates (body mass and flight feather development), nestling survival, body composition and mass of fledglings, and fledging age. Again, cooperation and coordination between these three subprojects will greatly enhance sample sizes and the power of statistical tests and inferences. The field crews for the three subprojects will work together to insure that data collection methods and procedures are consistent. In addition, the PIs for subprojects 95163E (D. Irons) and 95163F (D. L. Hayes) have agreed to assist this subproject in collecting food items for analysis of biochemical composition of the diet and in collecting data on the body composition of adults and chicks.

Additional cooperators include Dr. Scott Hatch (PI for subproject 95163D [formerly 95019] "Distribution and Abundance of Forage Fish as Indicated by Puffin Diet Sampling"). Dr. Hatch's subproject will collect forage fish from breeding tufted puffins on Naked Island and nearby Smith Island. Considerable overlap between diets of tufted puffins, black-legged kittiwakes, and pigeon guillemots is expected, so forage fish samples collected as part of subproject 95163D will be extremely useful for determining the biochemical composition and energy density of guillemot and kittiwake diets. Kathy Kuletz (PI for project 95031, "Reproductive Success as a Factor Affecting Recovery of Murrelets in PWS") will be working on Naked Island and may collect data on diet composition of breeding marbled murrelets in the course of her studies. These data will be extremely useful for comparison with diet composition of guillemots and kittiwakes.

Subproject 95163H "Proximate Composition and Energetic Content of Selected Forage Fish Species in PWS" (PI Dr. Graham Worthy) will assess the quality of various forage fish that are major prey for seabirds and marine mammals. Dr. Worthy's study will use fish specimens collected during shipboard surveys throughout the year to provide background data for the entire Seabird/Forage Fish project, including this subproject. Comparison between the proximate composition of forage fishes collected at sea and those fed to seabird nestlings will provide a valuable means of assessing the role of prey selection for enhancing the quality of seabird diets. Sample treatment and proximate analysis procedures will be consistent between subprojects 95163G and 95163H so that the results are comparable. These two projects will be coordinated so as not to duplicate efforts to obtain data on the proximate composition of forage fish used by guillemots and kittiwakes during the breeding season.

In order to understand dietary factors responsible for poor reproductive performance of seabirds in PWS, it is essential to conduct simultaneous shipboard work (hydroacoustic surveys in conjunction with net sampling) to assess the distribution, abundance, and species composition of forage fish in seabird foraging areas. That research was recently funded by the Trustees Council (project 94163) and the continuation of this project (subproject 95163A)

will be invaluable for interpretation of data on diets collected as part of the present proposal. In addition, the integrated studies that comprise the SEA Program (95320A-Y) will provide an important foundation for understanding ecosystem function in PWS as it relates to Seabird/Forage Fish interactions.

FY 95 BUDGET ($K)

Personnel	45.7
Travel	4.7
Contractual	24.6
Commodities	17.8
Equipment	0.0
Indirect Costs	39.2
Subtotal	132.0
Gen. Admin.	8.6
Total	140.6

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Proximate Composition and Energetic Context of Selected Forage Fish Species in Prince William Sound

Project Number:	95163H (formerly BAA-120)
Restoration Category:	Research (new)
Proposed By:	Physiological Ecology Research Laboratory, Marine Mammal Research Program, Texas A&M University
Lead Trustee Agency:	NOAA
Cost FY 95:	$43,000
Cost FY 96:	$35,000
Total Cost:	Unknown
Duration:	4 years
Geographic Area:	Prince William Sound
Injured Resource/Service:	Multiple resources

INTRODUCTION

As a result of damage assessment studies initiated after the *T/V Exxon Valdez* struck Bligh Reef in March, 1989, it was noted that several pelagic-feeding marine mammals and seabirds found in Prince William Sound (PWS) were apparently not recovering back to predisturbance population levels. This lack of recovery may be due to a number of factors, including possible food limitations. Food limitations have been suggested to be a problem for a variety of species which are found throughout the Bering Sea and Gulf of Alaska. While cause-effect relationships are difficult to demonstrate, changes in the energetic value of prey species can be quantified and these values used in the interpretation of energy availability to the impacted species. In PWS, two marine mammal species, harbor seals and sea otters, and several seabird species (common murre, harlequin duck, marbled murrelet, and pigeon guillemot) have been impacted and are not recovering. Others, such as killer whales, are recovering but may be indirectly inhibiting the recovery of other species if food competition is a problem.

There is increasing interest in the use of energetic models to study interactions between marine mammals or seabirds and their prey species. Often these models are based upon energy transfer between predator and prey. Although these models require information on

the energy context or proximate composition of these species, few data are available. Those data which have been published have limited application due to the inherent seasonal and annual variability in the value of the prey. The goal of this proposed subproject is to assess on a seasonal and annual basis, the value of the major prey species that would be of significance to the mammalian and avian predators listed above. These data will allow for the development of models that may yield reasons for the lack of recovery of these species.

NEED FOR THE PROJECT

This subproject will provide the background data necessary for future studies of food web dynamics and ecology of many species of fish, birds, and mammals of PWS. In any long-term study of foraging ecology, especially those investigating the recovery of impacted species, knowledge of prey species composition and energetic value is critical in the interpretation of consumption rates and therefore the impact of consumer species upon prey species stocks. Compositional analysis will also yield important information on the general quality of the environment by assessing the condition of important prey species.

PROJECT DESIGN

A. Objectives

The objectives of this subproject are to assess the seasonal and annual changes in the proximate composition of the major forage fish species in PWS. Data on the composition and energetic value of prey species for marine mammals and seabirds are very limited. Most data that are available are for commercial species that are consumed by humans. These data are further limited, in their ecological application, because they usually only analyze the edible fillets that people consume. Another major limitation in the database relates to the lack of an appreciation of the magnitude of seasonal variability which occurs. For example, herring can vary from as little as 3% lipid to as much as 22% lipid seasonally. Knowing the energy content and composition of these species will allow us to further enhance our understanding of the energetic and physiological ecology of the major consumer species in the PWS.

B. Methods

Species that should be collected are listed in Table 1. Samples should be frozen immediately after collection and be representative of the size classes which are known to be consumed by the consumer species in question.

All analytical techniques are described in detail in Worthy and Lavigne (1983) and Hislop et al. (1991). Analysis will be performed on freeze-dried, ground fish and will include

determinations of water content, total lipid content, total protein content, ash content, and energy density. Initially, wet mass, sex, and length of each individual specimen will be recorded. Specimens would then be combined, ground, and homogenized prior to freeze-drying. Water content will be determined gravimetrically by lyophilization of ground, homogenized prey until constant mass has been obtained. This will be accomplished using a LabConco Lyophilizer over a period of 4-5 days. Once the samples are dried, they are finely ground using a Spex 8000 Mixer/mill. This ground material will be used in all subsequent analyses and will be available for other investigators to use for future studies.

Lipid content will be measured gravimetrically by Soxhlet extraction using petroleum ether as the solvent. Protein content will be assessed using a modified Kjeldhal analysis and ash content will be determined by ashing at 550°C for 2 h in an ashing oven. Ground lyophilized samples will be analyzed for energy content by means of a Parr adiabatic bomb calorimeter.

C. Schedule

It is suggested that sampling be conducted a minimum of two seasons per year, when maximum productivity is occurring. If samples can be opportunistically obtained on a more regular basis, then a more detailed assessment of seasonal changes can be undertaken.

D. Technical Support

Collections will be done during Seabird/Forage Fish and SEA project cruises, charter cruises, and through the purchase of fish from local fishermen. All of the required equipment and expertise for this project are on-site at Texas A&M University - Galveston. This includes all of the specialized equipment required for the composition and energetics analysis, as well as archival capabilities for samples and the computer related software for full statistical analysis of the data.

E. Location

Collections will take place throughout PWS and surrounding waters.

PROJECT IMPLEMENTATION

This proposal is being submitted by the Physiological Ecology Research Laboratory (PERL) of the Marine Mammal Research Program (MMRP) of Texas A&M University - Galveston. The PERL is already collaborating with National Marine Fisheries Service, National Marine Mammal Laboratory, on two other projects related to the ecology of killer whales and use of stable isotope tracers in PWS. All of the data obtained in the present subproject will also be incorporated into the Integrative Marine Mammal Ecosystem Program.

The PERL has 20 years of combined experience in the analysis of prey species of marine mammals for their composition and energetic value. The ultimate aim of the PERL is to develop a library of prey species samples which could be made available to researchers for future analyses, as well as to make available data on long-term changes in prey species energetic values. The PERL currently is involved in similar projects in California, Texas, Florida, and eastern Canada.

COORDINATION OF INTEGRATED RESEARCH EFFORT

Collection of prey species will be undertaken during cruises by Seabird/Forage Fish and SEA projects. Additionally dedicated cruises may be required for the collection of certain species. Samples will be archived for potential future use by other investigators interested in this area. This subproject is an integral part of the Seabird/Forage Fish project and will provide key information to the synthesis report. Data collected will be used by the Seabird Energetics subproject (95163G) and subsequently by Puffins as Samplers (95163D), Kittiwakes as Indicators (95163C), and Pigeon Guillemot Recovery (95163F) components. To facilitate access to project data, the information collected from this subproject will be incorporated into a data base managed by the Trustee Council and by SEA.

FY 95 BUDGET ($K)

Personnel	20.5
Travel	3.0
Contractual	0.0
Commodities	3.5
Equipment	1.0
Indirect Costs	11.9
Subtotal	39.9
Gen. Admin.	3.1
Total	43.0

Table 1. Forage fish species of significance in the PWS System that are proposed to be studied for composition and energetic value in the present study. Suggested species were determined by assessing their importance to the various seabirds and marine mammals that are found in PWS. Some species are of importance only to the larger species such as killer whales (*Orcinus orca*).

Pacific herring	*Clupea harengus pallasi*
Rockfish	*Sebastes sp.*
Cutthroat trout	*Salmo clarkii*
Capelin	*Mallotus villosus*
Rainbow smelt	*Osmerus mordax*
Sand lance	*Ammodytes hexapterus*
Eulachon	*Thaleichthys pacificus*
Pacific cod	*Gadus macrocephalus*
Walleye pollock	*Theragra chalcogramma*
Sablefish	*Anopoploma fimbria*
Pacific sandfish	*Trichodon trichodon*
Pink salmon	*Onchorhynchus gorbuscha*
Sockeye salmon	*O. nerka*
King salmon	*O. tshawytscha*
Silver salmon	*O. kisutch*
Chum salmon	*O. iceta*

Seabird/Forage Fish - Program Management and Integration

Project Number:	95163I
Restoration Category:	Research (new)
Proposed By:	DOI, NOAA, ADFG
Cost FY95:	$80,700
Cost FY96:	$105,000
Total Cost:	Unknown
Duration:	6 years
Geographic Area:	Prince William Sound
Injured Resource/Service:	Multiple resources

INTRODUCTION

This component of the Seabird/Forage Fish project (95163A-I) will provide for scientific oversight, coordination, performance tracking, and integration of results. The suggested approach to program management employs elements that have been used effectively in other large, multidisciplinary programs for ecosystem assessment.

NEED FOR THE PROJECT

The Seabird/Forage Fish project, in its initial form and likely evolution, will comprise a number of interacting components involving specialists from various agencies, universities, and private organizations. To ensure that a cooperative and efficient research effort is achieved, it is essential that a program management plan be implemented to address such issues as team organization, scientific planning, scheduling and reporting, coordination between investigators and other existing programs and projects, data management, and quality assurance. This proposal recognizes that such functions cannot be solely vested in the individual Principal Investigators, that a responsible individual or group must be identified and dedicated to each of the management tasks, and that effective program management cannot be achieved at zero cost.

PROJECT DESIGN

A. Objective

The objective of program management and integration is to ensure a coordinated and scientifically productive research effort in support of restoration goals for seabirds.

B. Methods

The investigative team proposes to enlist one full-time individual (Program Coordinator) to implement and adaptively refine a management plan for seabird and forage fish investigations. The person recruited will possess a reasonable level of technical competence in marine ecology, fisheries, and/or avian science, as well as demonstrated skill in program organization and management. Duties of the Program Coordinator include (but are not limited to) the following: (1) coordinate activities among subprojects (methods, timing, and location of data collection, logistics, and contingency planning), (2) coordinate activities and facilitate data sharing with SEA investigations (95320), (3) facilitate communication among agencies and between this project and the oil spill restoration office (Executive Director, Chief Scientist, and staff), (4) schedule performance milestones for individual projects and assess success in meeting those milestones, (5) conduct quarterly meetings of the Principal Investigators, (6) prepare an annual synthesis report of forage fish and seabird projects and make an oral presentation at the annual science workshop, (7) provide scientific oversight and quality assurance by enlisting the services of a Technical Steering Committee (see below) and a qualified biometrician during project planning and review, and (8) explore opportunities for data management and system modelling, emphasizing cooperation with related efforts such as the Information Management System project (95089) and the SEADATA project (95320J).

The team further proposes to establish a three-member Technical Steering Committee with duties comparable to those of a project Chief Scientist. The Steering Committee will consist of individuals with expertise and professional stature in the relevant sciences (marine ecology, fisheries, avian biology, and population dynamics) who are not actively engaged in the field research program. The Technical Steering Committee will advise primarily on matters of overall scientific direction, but may also assist in defining specific research objectives and procedures.

C. Schedule

Annual scheduling to accomplish program management tasks will be the responsibility of the Program Coordinator. A reduced funding level is proposed for FY 95, reflecting the likelihood that this position will not be filled before March during the first year of the Seabird/Forage Fish study.

D. Technical Support

It is not expected that the Program Coordinator will have the skills and time to perform all of the identified tasks single-handedly. Rather, the position will come with a limited operating budget (ca. $40K) for purposes of travel and for contracting as needed the services of the Technical Steering Committee, a biometrician, technical writer, modeler, or data management specialist.

E. Location

Not applicable.

PROJECT IMPLEMENTATION

The position will most likely be filled through a personal services contract, as opposed to direct hire. Selection of the Program Coordinator and members of the Technical Steering Committee will be subject to approval by the Principal Investigators participating in the project.

COORDINATION OF INTEGRATED RESEARCH EFFORT

The central mission of this subproject is coordination of seabird and forage fish investigations, both within the parent Seabird/Forage Fish project (95163A-I) and between this project and other programs funded by the Trustee Council.

FY 95 BUDGET ($K)

Personnel	10.0
Travel	5.0
Contractual	60.0
Commodities	0.0
Equipment	0.0
Subtotal	75.0
Gen. Admin.	5.7
Total	80.7

Subsistence Food Safety Testing REVISED 10/10/94

Project Number:	95279
Restoration Category:	General Restoration (continuation of 94279)
Proposed By:	ADFG
Cooperating Agencies:	NOAA
Cost FY 95:	$146,500
Cost FY 96:	$51,500
Total Cost:	$198,000
Duration:	2 years
Geographic Area:	Prince William Sound, the Kenai Peninsula, and Kodiak Island
Injured Resource/Service:	Subsistence

INTRODUCTION

Subsistence uses of fish and other wildlife constitute a vital natural resource service that was injured by the *Exxon Valdez* oil spill. Data collected by the Alaska Department of Fish and Game's Division of Subsistence demonstrated this injury. Annual per capita subsistence harvests declined dramatically (from 4 percent to 77 percent decline compared to pre-spill averages) in ten of the communities in the path of the spill during the first year after the event. In subsequent years, levels of subsistence harvests, ranges of uses, harvest effort, and the sharing of resources have gradually increased in all of the spill area communities. Some subsistence users reported renewed confidence in traditional foods after receiving information and health advice from the Oil Spill Health Task Force. Others returned to using subsistence foods despite their misgivings because of economic and cultural reasons. Still others have traveled to unoiled areas to harvest resources. A view persists in the communities in the oil spill area, that the natural environment has changed in ways that still pose a potential threat to their health and their way of life. This view is partly fueled by observed abnormalities in resource species, and scarcity of some resources.

We propose to continue a subsistence restoration project involving the following communities; Chenega Bay, Tatitlek, Cordova, Valdez, Nanwalek, Port Graham, Seldovia, Kenai, Seward, Larsen Bay, Karluk, Old Harbor, Akhiok, Port Lions, Ouzinkie, Kodiak City, Chignik Lake, Chignik, and Chignik Lagoon.

In 1993 and 1994 the *Exxon Valdez* Trustee Council provided funding to restore the subsistence uses of fish and wildlife damaged by the *Exxon Valdez* Oil Spill. Community meetings were held in order to identify and map the specific areas and resources of continued concern to subsistence users. Samples of those subsistence species cited in community meetings as being of continued concern were collected from harvest areas identified during the mapping, with community representatives assisting in site selection as well as the collection of samples. The samples were analyzed for the presence of hydrocarbon contamination at the National Oceanic and Atmospheric Administration/National Marine Fisheries laboratory in Seattle. Community representatives were transported to the lab and given a tour of the facilities. The results of the tests, along with findings from other damage assessment and restoration studies, were interpreted by the Oil Spill Health Task Force, and reported to the communities in an informational newsletter and community visits.

At this point, there is little we can learn about subsistence food safety from additional hydrocarbon testing, and barring unforeseen circumstances, we will not be doing any further testing of this kind. The remaining samples will be analyzed by NOAA this winter; NOAA will provide a report of its hydrocarbon analysis in spring 1995. The results of the analysis, along with other information on subsistence food safety, will be communicated to the communities through two issues of the Subsistence Restoration Newsletter. In addition, we will put in place a system for getting samples of abnormal resources from subsistence users to biologists and pathologists for study, and will report the findings of the scientists to subsistence users.

This project will assist the Trustee Council in making decisions concerning restoration, enhancement or replacement of lost subsistence resources and uses.

PROJECT DESCRIPTION

The goal of the project is to restore the subsistence uses of fish and wildlife damaged by the *Exxon Valdez* Oil Spill. It is expected that by responding to the specific oil spill related concerns of subsistence users through testing of those resources, and reporting accurate health information back to the affected communities in clear, understandable language and in one on one discussions, the confidence of subsistence users in the resource can be restored. Past efforts in this direction have been partially successful.

A. Objectives

The last round of community meetings will take place in September 1995. The final two issues of the Subsistence Restoration Newsletter will be produced during 1995. Sampling kits will be in place in the communities by January 15, 1995, and the participating scientists will have been recruited by the same date. If successful, the sampling of abnormal resources will continue in future years.

B. Methods

Community meetings will be held in eleven communities (Chenega Bay, Tatitlek, Nanwalek, Port Graham, Seward, Larsen Bay, Karluk, Old Harbor, Akhiok, Port Lions, and Ouzinkie) to identify any continued oil spill related concerns of subsistence users. Other communities may be added if such concerns are noted by Subsistence Division researchers during community visits. Those communities where no concern is indicated in either the community meetings or by other communication will be dropped from the study.

A system will be put in place whereby subsistence users can send samples of abnormal resources that they encounter to biologists and pathologists to be examined. This will involve identifying, ahead of time, scientists willing to examine different types of specimens, and how each type of specimen needs to be handled, packaged and shipped. Community residents will need to be trained to properly preserve the different types of samples for shipping. Sampling kits will be placed in each community, and an account will be set up with an air carrier to transport samples from the communities to Anchorage. The training of subsistence users and the assembling of kits will be contracted out on a competitive basis. Reporting the information from the scientists to the subsistence users will be done by the Division of Subsistence.

Communication of food safety testing results and health advice to residents of the impacted communities will be achieved through production of two more issues of the Subsistence Restoration Newsletter. The newsletter will put the food safety information in context for subsistence users, following an evaluation of the information by the Oil Spill Health Task Force. Distribution of the newsletter will be followed by community visits, either informal visits to households or formal meetings, to complete the communication process.

The training of subsistence users to collect samples and the assembling of collection kits will be contracted out on a competitive basis. Typesetting and printing of two issues of an informational newsletter will also be contracted out. These tasks involve specific skills, and can be more efficiently completed by a professional.

C. Schedule

January 1995	Informational newsletter issued, community meetings
March 1995	Training complete, kits in place in communities, scientists lined up
April 1995	Informational newsletter issued
April 1996	Final report on fiscal year 1994 activities

Throughout the duration of the project, there will be periodic village visits as appropriate, and samples will be processed as they come in.

D. Technical Support

Technical support will be needed from biologists and pathologists with various state and federal agencies. Some have already indicated their willingness to participate in such a project.

E. Location

Field work will be conducted on Prince William Sound, the Kenai Peninsula, and Kodiak Island. The communities of Chenega Bay, Tatitlek, Nanwalek, Port Graham, Seward, Larsen Bay, Karluk, Old Harbor, Akhiok, Port Lions, and Ouzinkie will be involved. Other communities may be added if similar concerns are identified.

FY 95 BUDGET ($K)

Personnel	67.6
Travel	16.6
Contractual	44.8
Commodities	3.5
Equipment	0.0
Subtotal	132.5
Gen. Admin.	14.0
Total	146.5

Otolith Thermal Mass Marking of Hatchery Reared Pink Salmon in Prince William Sound

Project Number:	95320C
Restoration Category:	General Restoration (continuation of 94320C)
Proposed By:	ADF&G
Cost FY 95:	$701,100
Cost FY 96:	Unknown
Total Cost:	Unknown
Duration:	4 years
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pink salmon

INTRODUCTION

Each year approximately one half billion wild pink salmon fry emerge from the streams of Prince William Sound (PWS) and migrate seaward. Adult returns of wild pink salmon to PWS averaged approximately 10 million fish annually over the last two decades. The huge fry migrations and subsequent adult returns of pink salmon play major roles in the PWS ecosystem. Both juveniles and adults are important sources of food for many fish, birds, and mammals. Adults returning from the high seas also convey needed nutrients and minerals from the marine ecosystem to estuaries, freshwater streams, and terrestrial ecosystems. Wild pink salmon also play a major role in the economy of PWS because of their contribution to commercial, sport, and subsistence fisheries in the area.

Pink salmon returns originating from brood years subsequent to the EVOS have been aberrant or weak. Returns of wild and hatchery pink salmon in 1991 were only slightly below the mid-point of the pre-season forecast but arrived late and had very compressed run timing. The fish were also small and in advanced stages of sexual maturity long before reaching their natal streams. As a result of this small size and advanced maturity, the fish were of little commercial value. Returns of pink salmon in 1992 and 1993 were far fewer than expected. The 1992 return of wild pink salmon was the fourth smallest even year return in the last 30 years and the hatchery return was less than one third of expected. The 1993 return of wild pink salmon was the third smallest in the last 30 years and the hatchery return was less than one fifth of expected.

Pink salmon returns to PWS are dominated by hatchery produced fish. In addition to their dominance in the catch, hatchery stocks may also complicate fisheries management by straying into streams and spawning with wild fish. The magnitude and range of straying by both hatchery and

wild pink salmon stocks may significantly influence the success of restoration efforts. If straying of hatchery fish is significant and does lower the fitness of wild populations, restoration efforts which concentrate on insuring that spawning escapement goals are met may fail if no attention is given to the origins of the escapement. The definition of what constitutes a wild population and the scale of restoration efforts may change if significant straying also occurs among wild populations.

Coded wire tags have been the tool of choice for applying unique marks to populations of pink salmon in PWS. The methodology has been used extensively to estimate hatchery and wild stock contributions to commercial harvests and has also been used in preliminary straying research. Trustee council projects F/S 3, R60C, 93067, and 94320b have all incorporated this technology to estimate contributions of wild and hatchery pink salmon returns to PWS since the EVOS. Despite its usefulness, there are drawbacks to coded wire tag technology. Approximately one million coded-wire tags must be applied to pink salmon fry each year to obtain catch contribution estimates for returning adults. Tagging and recovery are both very labor intensive and the number of tags applied and recovered are sometimes inadequate for the levels of accuracy and precision desired. Coded wire tags are also intrusive, tags can be shed, and tagging may affect subsequent survival. Tag loss through shedding and differential mortality of tagged individuals affects subsequent estimates of adult returns based on tag recoveries. There is also recent evidence that poor placement of coded-wire tags may cause salmon to stray.

Because of the cost and problems associated with coded wire technology, other alternatives which mark a larger portion of the population with relatively inexpensive non-intrusive methods must be investigated. By marking all of the fish in a population, more accurate and precise contribution estimates for adult returns can be obtained at a lower cost than is possible with the current CWT technology. Non-intrusive marks which cannot be shed and which do not affect survival or behavior will eliminate important sources of error in mark-recapture population and straying rate estimates.

Thermally induced banding patterns have been used successfully as non-intrusive marks for large hatchery releases of salmon including pink salmon in Southeastern Alaska. The method requires a large initial capital expenditure for equipment to vary the thermal rearing regime in hatchery incubators, but contribution estimates for adult returns should be more accurate, precise, and less expensive to obtain than those derived from CWT methods. By funding the installation and developmental costs of a thermal banding program, the Trustees will be providing a powerful stock identification tool for resource restoration as well as practical management tool which resource agencies will continue to use after restoration end points are reached. The time line and budgets for the transition from coded wire tagging to otolith banding technology should include some overlap between the CWT and thermal banding programs to ensure that important information is not lost due to unforeseen problems (Table 1).

To fully evaluate restoration efforts straying and survival rates of wild populations must also be understood. Thermal banding may be a suitable for hatchery releases but may be impractical for wild salmon populations, located at remote sites throughout PWS, which have fry migrations extending over a period of two to three months in late spring and early summer. Induction of otolith banding patterns by immersion of larval or juvenile fish in oxytetracycline may be a more practical method to marking these populations. Therefore, we need to examine the feasibility of marking pink salmon fry in numbers comparable to those observed in wild streams using equipment and methods suited to remote field situations.

Table 1. Timeline and budgets for implementing otolith thermal banding and phasing out coded wire tagging as the stock identification method for hatchery pink salmon in PWS.

Marking and Recovery Timeline	FY94	FY95	FY96	FY97	FY98	FY99
CWT	Rec BY 92 Tag BY 93	Rec BY 93 Tag BY 94	Rec BY 94 Tag BY 95	Rec BY 95		
OTOLITH		Mark BY 95	Mark BY 96	Rec BY 95 Mark BY 97	Rec By 96 Mark BY 98	Rec BY 97 Mark BY 99
Approximate Marking and Mark Recovery Budgets						
Coded Wire Tags						
ADFG						
Tag Application	10	10	10	0	0	0
Tag Recovery	72	60	86	86	0	0
Subtotal	82	70	96	86	0	0
PWSAC/VFDA						
Tag Application	150	150	150	0	0	0
Tag Recovery	126	126	126	126	0	0
Subtotal	276	276	276	126	0	0
Trustee Council						
Tag Application	0	0	0	0	0	0
Tag Recovery	249	249	249	249	0	0
Subtotal	249	249	249	249	0	0
Coded Wire Tag Subtotal	607	595	621	461	0	0
Thermal Marks						
ADFG						
Mark Application	0	6	6	6	6	6
Mark Recovery	0	0	0	0	86	86
Subtotal	0	6	6	6	92	92
PWSAC/VFDA						
Mark Application	0	6	6	96	96	96
Mark Recovery	0	0	0	0	126	225
Subtotal	0	6	6	96	222	321
Trustee Council						
Mark Application	0	651	90	0	0	0
Mark Recovery	0	0	0	100	249	0
Subtotal	0	651	90	100	249	0
Thermal Mark Subtotal	0	663	102	202	563	413
Grand Total ADFG	82	76	102	92	92	92
Grand Total PWSAC/VFDA	276	282	282	222	222	321
Grand Total Trustee Council	249	900	339	349	249	0
Grand Total	607	1258	723	603	563	413

Note: This proposal is requesting 651K for thermal marking and 50K for oxytetracycline marking.

NEED FOR THE PROJECT

Development of a stock separation tool more precise and less expensive than currently used CWT methods will benefit wild salmon restoration efforts. Mass marking will provide fishery managers with a more powerful tool for use in reducing exploitation of damaged wild stocks, and the reduced cost of mass marking should free funds for use on other species. Although mass marking techniques will initially be developed for pink salmon in Prince William Sound, they can be applied to other salmon species in the EVOS impact area in the future. Development of mass marking techniques that can be applied to both wild (tetracycline marking) and hatchery (thermal marking) stocks will help ensure restoration of populations which are vital to the health of the marine, freshwater, and terrestrial portions of the PWS ecosystem as well as to the fishing industry which is the cornerstone of the area economy. The communities of Homer, Seward, Valdez, and Cordova will be most affected by this project, since the economy in these communities is based on the salmon resource.

PROJECT DESCRIPTION

This project will develop otolith mass marking as an inseason stock separation tool for salmon. Contribution estimation is essential if fishery managers are to reduce exploitation rates on damaged wild salmon stocks. Coded-wire tags are presently used for this purpose, but otolith marking is expected to provide more accurate and precise information at a lower cost. Recognizing the need to develop mass marking technology for pink salmon in PWS, the Alaska Department of Fish and Game (ADF&G) and Prince William Sound Aquaculture Corporation (PWSAC) reviewed the feasibility of otolith thermal marking at PWS hatcheries as well as otolith recovery in the commercial fisheries.

Otoliths are small bones in the inner ear of fishes. These bones can be marked through systematic changes in water temperature during egg incubation. The resulting marks are bands of light and dark material in the otolith similar to the bands in a tree. These induced marks can be used to identify hatchery-produced salmon in the fishery. Because all hatchery-produced salmon are marked using this technique, the cost of catch sampling is expected to be reduced, and the precision of inseason stock composition estimates are expected to be improved when compared to CWT techniques.

This project will be conducted cooperatively by the ADF&G, PWSAC, and Valdez Fisheries Development Association (VFDA). In 1995, PWSAC and VFDA will install the necessary equipment and otolith mark all pink salmon embryos in the Armin F. Koernig (AFK), Wally H. Noerenberg (WHN), Cannery Creek (CCH), and Solomon Gulch (SGH) hatcheries. The equipment will be installed in the summer of 1995, and marking will begin after the embryos have passed the eyed stage of development. Heated water will be introduced at the hatchery head troughs allowing treatment of millions of pink salmon embryos simultaneously.

The project will be conducted over a minimum of two pink salmon life cycles, marking both odd- and even-brood year fish. This approach is necessary because (1) 35% and 75% of odd- and even-brood year spawners utilize intertidal habitats, respectively, and (2) experience with two complete life cycles is needed to fully develop a program that integrates induced banding code quality, otolith processing rates and costs, and statistical designs for catch sampling. It is essential that the

relationship between wild salmon otolith banding patterns, induced otolith banding-code quality, otolith processing rates, and catch sampling design be fully integrated in the program. Cyclic temperature changes in salmon redds associated with the semi-diurnal tide produce natural otolith banding patterns in intertidal-spawning pink salmon. Embryos rearing in upstream redds are exposed to less regular stream temperature changes. Interannual differences in the proportion of upstream and intertidal spawners and natural stream temperature fluctuations may produce very different natural otolith banding patterns in wild pink salmon populations in different years. The quality of induced otolith banding-codes and natural banding patterns in wild populations will affect the ability of otolith readers to identify artificially marked hatchery salmon. A reduction in the reader's ability to identify marked fish will affect the sample sizes needed to estimate stock composition, the total cost of otolith processing, and ultimately the effectiveness of the program.

The validity of the otolith stock identification program also depends upon obtaining a representative sample of otoliths from the commercial fishery. Several sampling techniques will be evaluated in 1995 and 1996, using salmon marked after they are landed but before they are transferred to a processor, to determine how to sample tender loads. This portion of the study will examine the variation in stock composition among tenders as well as between processors. A cost function for catch sampling will be developed. This information will be used to produce an optimum allocation of sampling resources among tenders and processors. Monte Carlo simulation techniques will be used in conjunction with the data collected in this study to assess sampling power and refine sample sizes.

When otolith marked fry return as adults in 1997 and 1998, approximately 13,000 pink salmon otoliths will be processed in each year to estimate stock composition. The ADF&G Otolith Laboratory has the expertise required to rapidly process large numbers of otoliths. Approximately 250 otoliths can be processed and decoded by a single experienced technician within a working day. The Otolith Laboratory processed 2,300 otoliths in 1993 and more than 3,200 otoliths in 1994. These otoliths were recovered from Hawk Inlet commercial fishery catches and were used to estimate pink salmon contributions from the Gastineau Hatchery operated by DIPAC near Juneau.

Another component of this study will examine the feasibility of chemically marking otoliths by immersion of emergent fry in a dilute solution of tetracycline. This chemical has been used to apply marks in several fish species, and is regularly permitted by the United States Food and Drug Administration (FDA) for use as an antibiotic and otolith marking agent on fish destined for human consumption. Marks from tetracycline are permanent, relatively easy to apply, easily recognizable, and do not appear to be alter fish survival at low doses. While the most widely reported means of applying tetracycline marks is through feeding, several investigators have reported successful marking of spot and pinfish, whitefish, and striped bass by immersion in dilute solutions of this chemical. Pink and chum salmon have also been reported to have been successfully marked by immersion. While probably not cost effective for large hatchery releases reared in massive flow through incubator systems, tetracycline immersion is an attractive alternative for marking smaller wild populations of pink salmon as they migrate from their natal streams. Marking the total fry population in a stream would provide an accurate and precise tool for estimating total adult returns and survival. As a non-intrusive method which does not appear to alter behavior, chemical marking may also provide a powerful tool to investigate straying among wild populations.

A. Objectives

1. Develop engineering designs and install otolith thermal marking equipment in the AFK, WHN, CCH, and SGH hatcheries.

2. Apply otolith thermal marks to all pink salmon embryos rearing in the AFK, WHN, CCH, and SGH hatcheries.

3. Collect voucher samples and evaluate the quality of otolith thermal marks applied to pink salmon embryos at AFK, WHN, CCH, and SGH hatcheries.

4. Identify a feasible methodology for otolith marking wild pink salmon fry using tetracycline.

    a. Test and refine remote field camp methods and equipment to be used for immersing wild pink salmon fry in tetracycline solutions for up to 18 hours at varying temperatures.
    b. Determine the minimum immersion time and temperature needed to place otolith marks on 100% of the treated individuals.
    c. Compare short term growth and survival among untreated pink salmon fry and fry treated with tetracycline for various times and temperatures.

B. Methods

Objective 1

Project concept designs will be developed for water heating systems at AFK, WHN, CCH, and SGH hatcheries. Key physical constraints and biological parameters considered in development of the designs will include: (1) the hatchery floor plan and incubation water system, (2) historic pink salmon development and water temperature data, (3) current equipment on site, (4) approximate thermal marking schedule, and (5) the ability to increase temperature 3.5 C° at each incubator. It is expected that the equipment needed for water heating will be installed in a module attached to the outside of each hatchery to avoid loss of valuable interior space. Concept designs will include a boiler with a self-contained glycol system and heat exchanger housed in a portable skid-mounted covered module. Fuel, water, and electricity will be provided to each thermal marking module. Designs for plumbing and electrical installation may vary among hatcheries due to differences in the utility configuration at each site.

Otolith marking technology has been developed at the Gastineau Hatchery operated by DIPAC in Juneau, Alaska. The DIPAC thermal marking system has been successfully used to mark 120 million pink and chum salmon embryos in the hatchery. While the DIPAC system cannot mark all embryos simultaneously, hatchery operators have been able to work around these limitations to produce quality thermal marks. The experience gained at DIPAC will facilitate successful development of thermal marking technology at PWS hatcheries.

Pink salmon will be marked during the egg-to-hatch stage. This approach will eliminate the need, and increased cost, to degas incubation water since gas supersaturation is usually not a problem for salmon embryos prior to hatch but can cause gas bubble disease in alevins. Salmon eggs maintain a positive internal pressure which allows them to tolerate total dissolved gases (TDG) up to 110-116%.

It would be unusual to have TDGs greater than 110% in incubation process water, but it may be possible to drive TDGs this high through aggressive heating during thermal marking. TDGs will be monitored during the thermal marking process.

Objective 2

A unique otolith thermal banding code will be used for each pink salmon hatchery in PWS. A unique hatchery mark will provide consistency in both application and recovery of the mark. The thermal mark will be applied in the eyed-egg-to-hatch zone of the otolith. The time window to do this occurs between October and December and usually lasts an average of 35 days. This should allow sufficient time to apply thermal marks, since about 22 days will be required to apply banding codes of 5-7 rings at each hatchery (Table 2). Having a single code for each hatchery will allow estimation of survival rate by hatchery. However, hatchery operators may also need to estimate survival rate for three treatment groups within each hatchery. In this case, a treatment-group code composed of three rings will be applied in addition to the hatchery-specific mark to distinguish among treatment groups.

Table 2. Proposed marks for PWS pink salmon hatcheries. The thermal schedule describes the temperature regime. The letters "H" and "C" indicate thermal level, hot and cold; the difference between the two temperature levels being 3.5 degrees Centigrade. The number directly before the thermal level is the number of rearing-hours at that level. Numbers in parenthesis denote the number of repetitions.

Facility	Thermal Schedule	Banding Pattern
CCH	(3)48H:24C,(1)96H:24C,(3)48H:24C	III IIII
WHN	(4)48H:24C,(1)96H:24C,(2)48H:24C	IIII III
AFK	(5)48H:24C	IIIII
VFDA	(7)48H:24C	IIIIIII

Objective 3

Quality control during mark application is an important part of the otolith thermal marking program. The placement of the thermal banding code on the otolith is critical to mark quality. The banding code will be applied by lot (group of eggs taken on a single day) or groups of lots, when embryos are at the appropriate stage of development. Each incubating appliance will be sampled to ensure the mark was correctly applied. Temperature recorders will be installed at various points in the incubation system during mark application to document temperature changes. We expect that developmental stage will differ among hatchery lots and that this will affect mark placement on otoliths.

A stratified-random sampling design will be used to estimate the proportion of unmarked fry at each pink salmon hatchery. One month after mark application, a random sample of alevins will be taken from each lot, preserved in 100% ethanol, and sent to the ADF&G Otolith Laboratory in Juneau. Sample sizes will be selected in proportion to lot size, but a minimum of 100 alevins will be taken from each lot. At least thirty alevins will also be collected from each of 20 streams during the annual pre-emergent fry survey conducted by ADF&G. Samples will initially be used to validate each hatchery-specific code. Blind tests will then be conducted to evaluate each reader's ability to accurately distinguish between hatchery-specific codes and unmarked otoliths. The set of otoliths for the blind tests will be obtained from a random subsample of alevins (n=300) taken from each of the four hatchery samples combined with 600 wild alevins. These 1800 otoliths will be used to randomly construct six test sets of otoliths (n=300). These test sets should be similar to samples which will taken from the commercial fishery. Two blind tests will be conducted with each of three readers.

All otolith reading for this study will be done at the ADF&G Otolith Laboratory in Juneau. Otoliths will be extracted from alevins and fixed to a labeled glass slide with thermo-plastic cement. A grinding wheel will then be used to remove material from one side of the otolith and expose the internal structures. Depth of grinding will be monitored by repeated viewing the otolith under a dissecting microscope. After the internal bands are exposed, the thermal mark will be decoded under a compound microscope.

Objective 4

Chemical marking feasibility studies will be conducted adjacent to the CCH in Unakwik Inlet using equipment identical to that proposed for future field camp use. Fry for the study will be obtained from the hatchery.

a. Testing Marking Procedures

A buffered solution of tetracycline hydrochloride (Tetra-bac) diluted to 400 parts per million in fresh water will be used to mark all treatment groups in this experiment. Emergent hatchery pink salmon fry immersed in this dose for 24 hours during a small test conducted by the Cordova ADF&G staff in March of 1994 had no short term mortalities and exhibited no signs of stress during exposure. This study will test 12 unique treatment combinations (t_{ij}) of immersion time (i) and temperature (j). Immersion times of 3, 6, 12 and 18 hours (i = 1,2, 3, and 4) will be tested at 2°, 5°, and 8° C (j = 1,2, and 3). There will be five replicates (r = 1,2,3,4, and 5) for each t_{ij}.

During NRDA F/S Study 3, as many as 50,000 fry were observed migrating daily from moderate sized pink salmon streams in 1990 and 1991. Larger streams having peak daily fry migrations of 100,000 fish per day may be considered for future enumeration and tagging studies, if otolith marking proves to be feasible. Present projections for fry handling and personnel time, as well as fuel and camp supply needs, indicate that a typical two-person crew at a remote fry enumeration site can heat approximately 540 liters of tetracycline solution daily. Under these constraints, loading densities of approximately 2,500 fry per treatment bag (approximately 180 fry per liter) must be achieved if 100,000 fry are to be marked daily. The feasibility of using loading density for immersion marking will be examined in this study.

Three 750 liter water baths, one for each temperature treatment, will be prepared in large insulated fish totes. Water will be heated and maintained at temperature by thermostatically controlled electric immersion heaters supplied by a gasoline powered generator. Fry emerging from hatchery incubators will initially be divided into 60 groups (12 treatments x 5 replicates) of 600 individuals each. Each 600 fry group will be placed in a clear polyethylene bag containing four liters of hatchery (stream) water at ambient stream temperature. Each bag will be aerated using compressed air and air stones. A pre-mixed 135 ml. buffered tetracycline solution will be added to the each of 60 treatment bags. Fifteen additional bags will be left untreated and used for controls (c_{ij}) to test the effects of tetracycline on short term survival at different temperatures (five bags per temperature) and exposure times. Treatment bags and control bags will be transferred in equal numbers to each of the three heated water baths. The water temperature in treatments bags will be monitored and when all bags in a tote have reached the desired immersion temperature, timing for duration of immersion will begin. At the endpoint for each time treatment, five treatment bags will be removed from each of the three totes and transferred to a saltwater enclosure in front of the hatchery. After acclimating them to seawater temperature, fry from each bag will be transferred to separate saltwater rearing cylinders constructed of fine meshed plastic screen (vexar). In addition, at the start of the treatment day fifteen groups of 600 fry each will be transferred directly from the hatchery into saltwater rearing cylinders. These fry will act as controls for testing the marking effectiveness of each of the 12 treatments as well as the overall effect of the marking on survival. All treatment and control groups will be held and fed in saltwater rearing pens for four weeks to insure that the treatment band is deposited on the otolith and that otolith growth occurs beyond the marking band. At the end of four weeks, fry from each rearing cylinder, which represent one replicate of a treatment group, will be preserved in a light proof black plastic bottle containing 90 % ethyl alcohol and shipped to the ADF&G Otolith Processing Laboratory in Juneau for otolith removal and processing.

b. Determining the Minimum Required Treatment

If otolith marked wild populations are considered to be representative of unmarked wild populations, we must assume that marking does not significantly affect survival. To examine this assumption, the number of mortalities in each 600 fish treatment and control group will be recorded for the treatment and rearing periods. A one way analysis of variance will be used to test for total mortality differences between each treatment group and their corresponding controls. Any treatment which has total mortalities significantly greater than those observed in the corresponding control group will be eliminated from further consideration as a potential marking treatment.

All otolith extractions and processing will be completed in the ADF&G Otolith Lab in Juneau. Initially, a random sample of 30 otoliths from the first replicate of the maximum treatment group (18 hours at 8° C) will be mounted and processed to determine if the maximum treatment produced a tetracycline mark. If some of these 30 otoliths are not marked, we will assume that 1) lesser treatments would be equally or less effective, 2) tetracycline marking procedures tested are not effective, and 2) the experiment should be terminated with no further expenditure of funds for otolith processing. If all 30 otoliths are marked then a systematic search will be initiated to find the minimum treatment required to place a recognizable mark on 100% of treated individuals.

A systematic search for the minimum required treatment will proceed as followings:

(1) Thirty otoliths from each replicate of t_{11} will be processed and examined by a trained observer.
(2) If all 30 otoliths are marked, 30 more otoliths from the first replicate t_{111} will be extracted, mounted on slides then randomly mixed with 30 similarly prepared otoliths from the control group of fish c_0. The observer will examine this pool of 60 otoliths and attempt to correctly identify the treated individuals.
(3) If the observer correctly identifies all of the treated individuals from a pool of t_{111} and c_0, the procedure in step (2) will be repeated three more times for similar t_{111}, t_{112}, t_{113}, t_{114}, t_{115} and control pools.
(4) If at any point in these tests the observer fails to detect a mark on an otolith which has been treated, the procedure will terminate for $i=1$ and begin anew at step (1) for $i=2$ through *4*.
(5) If the observer fails to classify any time treatments of temperature $j=1$ with 100 percent accuracy the steps (1) through (4) will be repeated for treatments t_{12} through t_{34}.
(6) The minimum treatment suitable for marking is found when the observer correctly identifies all marked individuals in all replicates for a treatment t_{ij} .

After the minimum suitable treatment is identified, 30 otoliths may also be examined from the first replicates of each remaining untested temperature treatment groups which had no significant mortalities. This will be done to determine whether more readily identifiable marks are available and if accidentally elevated temperature in the field may adversely affect marking. If a better mark is identified, steps one through three from the list above will be repeated for that treatment. If 100% classification accuracy is achieved by the observer for all replicates of the treatment, this new treatment will be designated as the minimum treatment of choice and the former selected treatment will become the alternate treatment of choice. The treatment used in field studies will be the one which resulted in the lowest mortality rate during treatment and subsequent rearing.

c. Testing Effects of Tetracycline

If results of the marking study indicate that tetracycline is a suitable marking agent for use on wild pink salmon, an FDA permit will be obtained for use in future years when marked fish are to be released. As part of the permit, the FDA stipulates that investigators must contribute to furthering the knowledge about the biological effects of tetracycline. Typically this means that a set of controls be maintained for each treatment application of the chemical and that results of treatments and controls be compared. Because fry are not being released in our pilot study, such comparisons are not required. However, since they can be done at little additional cost, we plan to doing them to facilitate obtaining future FDA permits for fish to be released.

Mortalities from each of the treatment controls (c_{ij}), consisting of fry held in fresh water but subjected to time and temperature treatments, will be enumerated for the treatment and rearing phases of the experiment. A one way analysis of variance will be used to test for significant differences between mortalities observed among controls and those observed in the corresponding treatment groups immersed in tetracycline.

C. Schedule

Mass thermal marking will be conducted over at least pink salmon life cycle for both the odd- and even-brood year populations. Embryos will be otolith marked in the fall of 1995 and 1996. The adult fish from the 1995 and 1996 year classes will return to PWS as adults in the summers of 1997 and 1998. The chemical marking portion of the study is a feasibility study designed to determine whether this technique can be applied to wild populations.

Table 2. Schedule of activities for otolith thermal marking program over the duration of the project (FY 1995-1998).

Date	Activity
2/95- 8/95	Install water heating equipment at PWS pink salmon hatcheries
10/95-12/95	Apply otolith banding codes to brood year 1995 embryos at hatcheries
2/96- 4/96	Apply coded-wire tags to pink salmon fry at hatcheries
4/1/96	Submit annual project report for FY 1995
7/96- 9/96	Develop a method to collect random otolith samples from tender boats
10/96-12/96	Apply otolith banding codes to brood year 1996 embryos at hatcheries
4/1/97	Submit annual project report for FY 1996
8/97-10/97	Recover thermally marked even-brood year adults from the commercial fishery
8/97-12/97	Determine optimal allocation of sampling effort and refine sample sizes
4/1/98	Submit annual project report for FY 1997
8/98-10/98	Recover thermally marked odd-brood year adults from the commercial fishery
8/98-12/98	Re-evaluate optimal allocation of sampling effort and sample size estimates
4/1/99	Submit annual project report for FY 1998

Table 3. Schedule of activities for tetracycline marking component in 1995.

Dates	Activity
4/5 - 5/5	Apparatus set up at Cannery Creek Hatchery, marking immersion treatments, and rearing of treatments and controls
5/5 - 5/15	Dismantle and remove equipment at Cannery Creek and ship otolith samples to Otolith Lab
5/15 - 9/15	Process otoliths at Otolith Lab
4/1/95	Submit annual project report for FY 1995

D. Technical Support

Data archiving services will be required to insure that all information obtained from this project is adequately documented and catalogued. The ADF&G Commercial Fisheries Management and Development Division will provide biometrics support both for review of project methods and for

data analyses. The ADF&G Otolith Laboratory will review project methods and process otoliths.

E. Location

This project will be conducted in the PWS region. Embryos will be thermally marked at the AFK, WHN, CCH, and SGH hatcheries operated by the PWSAC and VFDA. Otolith code development and quality control work will be conducted at the ADF&G Otolith Laboratory in Juneau. In future years, an otolith catch sampling program will be developed. Catch sampling will likely occur in all PWS communities, as well as, Anchorage, Kenai, and Kodiak. Data analyses and reporting will be completed by ADF&G staff in Cordova and Anchorage. The tetracycline marking component of the project will be conducted at the CCH Hatchery.

PROJECT IMPLEMENTATION

ADF&G will administer contracts with VFDA and PWSAC for the installation of thermal marking equipment in PWS hatcheries and will develop otolith catch sampling designs. ADF&G is responsible for managing the pink salmon resource in the PWS area. In addition, ADF&G is responsible for the development, oversight, and evaluation of the salmon enhancement program. ADF&G has considerable experience in large-scale fish marking programs including the PWS coded-wire tag program. The existing ADF&G fishery management program in PWS will provide salmon catch data needed to complete this project. PWSAC and VFDA will install and operate otolith thermal marking equipment at four pink salmon hatcheries in PWS. These organizations operator these facilities.

COORDINATION OF INTEGRATED RESEARCH EFFORT

The Otolith Mass Marking Project (94187) will be highly integrated with several other salmon restoration projects in PWS. This project will complement the Sound Ecosystem Assessment (SEA) program (Project 94320). SEA is a multi-disciplinary program designed to develop an understanding of the mechanisms regulating ecosystem function in PWS. During its first year, SEA will focus on the interactions of pink salmon and herring with other components of the PWS ecosystem. Otolith marked pink salmon will provide a valuable tool for examining interactions between wild and hatchery salmon during the early marine period. The Salmon Growth component of SEA will utilize otolith marked juvenile pink salmon to (1) evaluate habitat overlap between wild and hatchery salmon, (2) compare size composition of wild and hatchery salmon in mixed schools, and (3) estimate juvenile salmon mortality within PWS and in the Gulf of Alaska. The Salmon Predation component of SEA will utilize otolith marked juvenile salmon to determine whether predators select wild or hatchery salmon. Projects 94185 (Wild Salmon Straying) and 94192 (Hatchery Salmon Straying) were deferred in 1994 to allow for development of mass marking technologies in PWS. Without the availability of a non-intrusive mass marking methodology, estimates of total return, survival, and straying rates for stream specific wild salmon populations will be based on various assumptions that will remain difficult or impossible to test. Therefore, the monitoring, research and restoration objectives of this project also have an important bearing on interpretation of several other

projects including the Pink Salmon Genetics project (94189), and the Pink Salmon Egg and Alevin Mortality (94191) projects.

FY 95 BUDGET ($K)

Personnel	25.7
Travel	1.6
Contractual	632.2
Commodities	10.4
Equipment	8.2
Subtotal	678.1
Gen. Admin.	29.0
Total	701.1