19.11.05

FY 2002

Approved Detailed Project Descriptions and Budgets

For Deferred FY 02 Projects

Approved

8/6/01

12/11/01

and

4/18/02

and one revised

6/13/02

FY 02 WORK PLAN -- PROJECTS APPROVED BY TRUSTEE COUNCIL 8/6/01 & 12/11/01

Proj.No.	Project Title
02012-BAA	Photographic and Acoustic Monitoring of Killer Whales in Prince William Sound and Kenai Fjords
02052	Natural Resource Management and Stewardship Capacity Building
02100	Public Information, Science Management, and Administration
02126	Habitat Protection and Acquisition Support
02144	Common Murre Population Monitoring
02154	Support Costs: Archaeological Repository/Display Facilities/Exhibits
02159	Surveys to Monitor Marine Bird Abundance in Prince William Sound During Winter and Summer 2002
02163M	APEX: Numerical and Functional Response of Seabirds to Fluctuations in Forage Fish Density
02190	Construction of a Linkage Map for the Pink Salmon Genome
02195	Pristane Monitoring in Mussels
02210	Prince William Sound/Lower Cook Inlet Youth Area Watch
02245	Community-Based Harbor Seal Management and Biological Sampling
02247	Kametolook River Coho Salmon Subsistence Project
02250	Project Management
256B-CLO	Sockeye Salmon Stocking at Solf Lake
02290	Hydrocarbon Database and Interpretation Service
02320	Sound Ecosystem Assessment (SEA): Printing the Final Report
02340	Toward Long-Term Oceanographic Monitoring of the Gulf of Alaska Ecosystem
02360-BAA	The *Exxon Valdez* Oil Spill: Guidance for Future Research Activities
02395	Workshop on Nearshore/Intertidal Monitoring
02396	Alaska Salmon Shark Assessment
02401	Assessment of Spot Shrimp Abundance in Prince William Sound
02404	Testing Archival Tag Technology in Coho Salmon
02407	Harlequin Duck Population Dynamics
02423	Patterns and Processes of Population Change in Selected Nearshore Vertebrate Predators
02441	Harbor Seal Recovery: Effects of Diet on Lipid Metabolism and Health
02455	GEM Data System
02462-CLO	Effects of Disease on Pacific Herring Population Recovery in Prince William Sound
'76	Effects of Oiled Incubation Substrate on Pink Salmon Reproduction
2479	Effects of Food Stress on Survival and Reproductive Performance of Seabirds
02492	Were Pink Salmon Embryo Studies in Prince William Sound Biased?

FY 02 WORK PLAN -- PROJECTS APPROVED BY TRUSTEE COUNCIL 8/6/01 & 12/11/01

Proj.No.	Project Title
02514	Lower Cook Inlet Waste Management Plan Implementation Phase 1
02535	EVOS Trustee Council Restoration Program Final Report
02538	Evaluation of Two Methods to Discriminate Pacific Herring Stocks along the Northern Gulf of Alaska
02543	Evaluation of Oil Remaining in the Intertidal from the *Exxon Valdez* Oil Spill
02550	Alaska Resources Library and Information Services (ARLIS)
02552-BAA	Exchange Between Prince William Sound and the Gulf of Alaska
02558	Harbor Seal Recovery: Application of New Technologies for Monitoring Health
02561	Evaluating the Feasibility of Developing a Community- Based Forage Fish Sampling Project for GEM
02574-BAA	Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound
02584	Evaluation of Airborne Remote Sensing Tools for GEM Monitoring
02585	Lingering Oil: Bioavailability and Effects to Prey and Predators
02593	River Otters and Fishes in the Nearshore Environment: A Synthesis
02600	Synthesis of the Ecological Findings from the EVOS Damage Assessment and Restoration Programs, 1989-2001
02603	Implementation of an Ocean Circulation Model: A Transition from SEA to GEM
02608	Permanent Archiving of Specimens Collected in Nearshore Habitats
02610	Kodiak Archipelago Youth Area Watch
02612	Detecting and Understanding Marine-Terrestrial Linkages in the Kenai River Watershed
02614	Monitoring Program for Near-Surface Temperature, Salinity, and Fluorescence in the Northern Pacific Ocean
02622	Digital Maps from Existing Seasonal Environmental Sensitive Area Maps: Cook Inlet/ Kenai Peninsula
02624-BAA	A CPR-Based Plankton Survey Using Ships of Opportunity to Monitor the Gulf of Alaska
02630	Planning for GEM
02636-BAA	Management Applications: Commercial Fishing
02649	Reconstructing Sockeye Populations in the Gulf of Alaska over the Last Several Thousand Years
02656	Retrospective Analysis of Nearshore Marine Communities Based on Analysis of Archaeological Material and Isotopes
02667	Effectiveness of Citizens' Environmental Monitoring Program
02668	Developing an Interactive Water Quality and Habitat Database and Making it Accessible on the Web
02671	Coordinating Volunteer Vessels of Opportunity to Collect Oceanographic Data in Kachemak Bay and Lower Cook Inlet

19.11.05 Revised 6-13-02
FINAL

02052rev2.doc (revised 6/13/02)

Tribal Natural Resource Stewardship and Capacity Building

Project Number:	02052
Restoration Category:	General Restoration
Proposer:	P. Brown-Schwalenberg/CRRC
Lead Trustee Agency:	ADFG
Cooperating Agencies:	None
Alaska SeaLife Center:	No
New or Continued:	Continued
Duration:	8th year, 8 year project
Cost FY 02:	$131,400
Geographic Area:	All
Injured Resource/Service:	Subsistence

ABSTRACT

In FY 02, this project will shift its focus from community involvement to the integration of Tribal Natural Resource Progra... Monitoring and Research Program (GEM). Communities involved... Region/Chignik Lake, Chenega... Nanwalek, Port Graham, Sewar... will focus on three objectives: (... communities (Tatitlek, Eyak (C... an Inter-Tribal Integrated Natu... region, and (c) actively partici... goal of the Trustee Council cor...

Cheri-
6/21/02
This is new version of DPD — wording changes were required by Dept. Justice before they'd agree to the court notice.... Please substitute what's in official & public record w/ this. (Does that make sense?) Anyplace else we should circulate this?)
Thanks,
Sandra

14.11.02 Revised 6-13-02
FINAL

02052rev2.doc (revised 6/13/02)

Tribal Natural Resource Stewardship and Capacity Building

Project Number:	02052
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New or Continued:	Continued
Duration:	8th year, 8 year project
Cost FY 02:	$131,400
Geographic Area:	All
Injured Resource/Service:	Subsistence

ABSTRACT

In FY 02, this project will shift its focus from community involvement to the integration of Tribal Natural Resource Programs with the Gulf Ecosystem Monitoring and Research Program (GEM). Communities involved in the project include those in the Alaska Peninsula Region/Chignik Lake, Chenega Bay, Cordova (Eyak), Kodiak Island Region/Ouzinkie, Nanwalek, Port Graham, Seward (Qutekcak), Seldovia, Tatitlek, and Valdez. In FY 02, project will focus on three objectives: (a) completing Tribal Natural Resource Plans in five pilot communities (Tatitlek, Eyak (Cordova), Port Graham, Nanwalek, and Ouzinkie), (b) completing an Inter-Tribal Integrated Natural Resource Stewardship Plan for the Chugach/Lower Cook Inlet region, and (c) actively participating in GEM planning meetings and workshops. The long-term goal of the Trustee Council contribution to the project is local stewardship of marine resources.

INTRODUCTION

In FY 02, this project will shift its focus from community involvement to the integration of Tribal Natural Resource Programs with the Gulf Ecosystem Monitoring Program. The project is designed to enhance the stewardship capacity of the Alaska Native community in the spill region. This project will also examine the communities' interests, priorities and activities through their Tribal Natural Resource Programs and how these relate to the GEM Program. Candidate projects emerging from our planning effort will exhibit a blend of modern measurement science and traditional observation, which will be beneficial to both the GEM Program and the Tribal Natural Resource Programs.

After a pilot effort beginning in three communities in FY 95, ten Community Facilitators were hired in FY 97 through cooperative agreements with the Village Councils of Chenega Bay, Chignik Lake (Alaska Peninsula Region), Eyak (Cordova), Nanwalek, Ouzinkie (Kodiak Island Region), Port Graham, Qutekcak (Seward), Seldovia, Tatitlek, and Valdez to involve communities in the EVOS restoration process. The Spill Area Wide Community Involvement Coordinator worked with the Community Facilitators to promote communication among the EVOS Trustee Council, the communities, and scientists. Their efforts continued through FY 00 and FY 01 while five pilot communities (Cordova, Nanwalek, Ouzinkie, Port Graham, and Tatitlek) also began development of Tribal Natural Resource Plans, designed to assist the communities in having a more active role in GEM. These pilot communities were funded at a higher level for the additional work required.

The purpose of the Tribal Natural Resource Plans is relatively basic and will 1) document traditional harvest areas; 2) document critical habitats and important cultural areas; 3) identify priority species used by the Tribes; 4) identify priority issues related to natural resources; and 5) develop a process by which Tribes can properly address natural resource concerns through cooperative projects and agreements with existing land managers and resource management agencies, such as the state and federal governments and the regional and village Native corporations. These plans are designed to provide a forum for tribes to have input into the policies and decisions that affect them. Cooperation between state and federal management agencies and the Tribes is the preferred method since the Tribes recognize that they are not the actual landowners, and as such, do not have management authority over the land or its resources. The subsistence-based lifestyle that the Tribes have established and prefer depends upon a sustainable natural resource base, as well as a healthy environment. This subsistence-based lifestyle preference provides the impetus for direct Tribal involvement in the management decision-making process.

In FY 00, workshops were held for the communities in the Chugach Regional Resources Commission region and spill area. The purpose of these workshops was to further develop the technical capacity to conduct research and monitoring projects associated with the *Exxon Valdez* Oil Spill. This increased capacity is a key component in their efforts to ensure the sustainability of their subsistence resources. One workshop was held in December 2000 between the village corporations and Tribes to discuss ways of cooperatively managing village corporation lands. Additionally, the corporations and Tribes in Prince William Sound have been working extensively with the United States Forest Service to ensure their involvement in the Chugach

National Forest Management Plan Revision currently underway. Cooperative and collaborative management of lands and resources have been actively discussed and strategies for further developing a formal relationship are underway. In FY 00, the pilot communities, as well as members of the CRRC Board, traveled to Lac du Flambeau, Wisconsin to observe the Tribal natural resource research and monitoring program currently being conducted by the Lac du Flambeau Band of Lake Superior Chippewa Indians. This trip was an effort to provide the communities with an opportunity to experience first hand a model Tribal Natural Resource Program, which could perhaps serve as a model for programs in the spill area. This "model" we are interested in replicating is a natural resource program that includes departments that address all aspects of natural resources and the environment, including water resources, fisheries, fish culture, wildlife, forestry, air quality, water quality, migratory birds, and wetlands. Since the management authority of the tribes in the Lower 48 is quite different than that of the Alaska tribes, it is understood that some aspects of their program do not apply here. For instance, the Lac du Flambeau Tribe has a conservation enforcement office who provides enforcement over both Tribal members and non-members alike. In addition, the program also includes a Tribal Court system that can hear cases on both state and Tribal violations. Our mission was to take from their program what is relevant and legal in Alaska and bring that model to the tribes here. It was also an opportunity for the Alaska representatives to see Tribal Members working in all areas and in all professional capacities in the tribal natural resource arena. Finally, this trip served to encourage more tribal involvement in the community research and monitoring aspects of the GEM Plan.

In FY 01, the CRRC Board of Directors held a Strategic Planning Session. During this meeting they identified Tribal Natural Resource Plan development along with an EVOS $20 million Tribal Community Fund as top priorities of CRRC. The Board of Directors also prioritized the communities' involvement in GEM and community involvement/Traditional Ecological Knowledge, indicating their interest in remaining involved in the EVOS process. In October of 2000, project personnel (the Community Facilitators, Natural Resource Specialists, Science Advisor, Principal Investigator, TEK Specialist, and Spill Area Wide Community Involvement Coordinator) all participated in the Trustee Council's GEM Workshop, advocating for meaningful community involvement and TEK being incorporated into the GEM Plan/Program.

In March 2001, the Principal Investigator and Spill Area Wide Community Involvement Coordinator, in cooperation with the Chugach Alaska Corporation, Chugachmiut, and North Pacific Rim Housing Authority, organized the Chugach Regional Summit on Natural Resources for participation by the Board of Directors of the Chugach Region Native Corporations, Tribal Councils, and regional organizations. The Community Facilitators and Natural Resource Specialists also participated. During this Summit the communities identified barriers, and developed solutions, for the Tribal Natural Resource Programs and discussed ways to assist in creating cooperative relationships between the Tribes, Native corporations, and state and federal management agencies in the area of jurisdiction, enforcement and management of natural resources. Meetings were held in Nanwalek and Port Graham to explore these opportunities that resulted in cooperative projects being developed for submission to the Federal Subsistence Board.

In FY 02, specific project tasks will be (a) completing Tribal Natural Resource Plans in five pilot communities (Tatitlek, Eyak (Cordova), Port Graham, Nanwalek, and Ouzinkie), (b) completing an Inter-Tribal Integrated Natural Resource Stewardship Plan for the Chugach/Lower Cook Inlet region, and (c) actively participating in GEM planning meetings and workshops. In addition, the Tribes will work to further develop their technical capacity to conduct research and monitoring projects under the GEM program and to identify common areas of interest between the Tribal Natural Resource Programs and GEM. Once these common areas of interest are identified, the goal will be to develop methods by which Tribes can assume specific research and monitoring activities of GEM, while leveraging other funds to implement other aspects of their Tribal Natural Resource Plans.

In FY 02, the position of Spill Area Wide Community Involvement Coordinator will be replaced with a Tribal Natural Resource Program Planner. This person (to be hired) will be responsible for coordinating the overall project out of the CRRC office, to accomplish the following tasks:

1. Continue the involvement of community members and Tribal Natural Resource Programs throughout the spill region in the development of the GEM Program. This will include active participation of the Tribal Natural Resource Program Planner and Tribal representatives in various GEM planning meetings and workshops, such as the January 2002 EVOS Annual Workshop and the intertidal workshop to be held in Homer in April.

2. Serve as contact point for natural resource personnel in each of ten participating communities (Alaska Peninsula Region/Chignik Lake, Chenega Bay, Cordova, Kodiak Island Region/Ouzinkie Nanwalek, Port Graham, Seldovia, Seward, Tatitlek, and Valdez). The Tribal Natural Resource Program Planner will:

    a. Coordinate and assist in the completion of Tribal Natural Resource Plans in the five pilot communities and incorporate individual plan information into an Inter-Tribal Integrated Natural Resource Stewardship Plan.
    b. Coordinate the participation of the Tribes in the EVOS annual restoration workshop and various GEM planning meetings and workshops.
    c. Work with the TEK Specialist (see below) to facilitate participation of natural resource personnel in capacity building efforts (e.g., training sessions, workshops, conferences).

3. Communicate findings and results of relevant EVOS research to the Natural Resource Specialists.

4. Provide input at Restoration Work Force and Public Advisory Group meetings.

5. Attend (in person or by teleconference) all Trustee Council meetings and report to the Tribes on relevant actions taken.

6. Prepare quarterly project status reports and an annual project report, as required by the Trustee Council's reporting procedures.

Trustee Council funding will support roughly one-quarter time of an existing Natural Resource Specialist (or similar position) in each of the five pilot communities. The specific tasks to be undertaken by the Natural Resource Specialists include the following:

1. Complete Tribal Natural Resource Plans and begin work, if possible, on action (i.e., implementation) plans. The current status of the plans is as follows:

Tatitlek: Plan completed. Next step is to prepare species-specific action plans. MOA with Tatitlek Corporation is in place regarding Tribal monitoring of resources on Corporation lands.
Eyak (Cordova): First draft of plan is done.
Port Graham: Third draft of plan is done. MOA with Port Graham Corporation is in place regarding Tribal management of resources.
Nanwalek: First draft of plan is done.
Ouzinkie: Plan not yet drafted.

2. Participate in completion of an Integrated Inter-Tribal Natural Resource Stewardship Plan. This plan, which addresses the Chugach/lower Cook Inlet region, is currently in its third draft.

3. Participate in the EVOS Annual Restoration Workshop, various GEM planning meetings and workshops, the Native American Fish & Wildlife Society Conference, Alaska Forum on the Environment conference, and the EPA Region X environmental management conference.

4. Work with project staff to identify common areas of interest between the Tribal Natural Resource Plans and the GEM Program.

5. Continue building the technical natural resource capacity at the community level through participation in training and education opportunities, including research and monitoring techniques.

6. Inform the Tribal Natural Resource Program Planner of community issues, concerns, or questions regarding GEM. These issues could be identified through community meetings or through other means, and could include ideas for integrating GEM and the Tribal Natural Resource Plans.

7. Coordinate any activities that have a direct impact on the local community resources and any research projects that can be complemented by the Tribe's traditional knowledge of the traditional use areas.

In addition, Project 02052 will support travel necessary for participation of other communities (Chenega Bay, Valdez, Seldovia, Seward (Qutekcak), Chignik Lake) in the spill region in various GEM planning meetings and workshops and in capacity-building activities (e.g., training and workshops).

The specific tasks for the Traditional Ecological Knowledge (TEK) Specialist will be to:

1. Assist the Tribal Natural Resource Programs with completion of their Tribal Natural Resource Plans, specifically in the areas of incorporating traditional ecological knowledge.

2. Assist spill area communities as requested, in developing methods for documenting TEK and otherwise incorporating it into research and monitoring programs related to GEM.

3. Provide other assistance as necessary to the project and to the Tribal Natural Resource Program Planner.

The specific tasks for other science advisors will be to:

1. Work with the communities to identify GEM related projects within their Tribal Natural Resource Plans.

2. Coordinate community input in the GEM program, including serving as the liaison with other GEM scientists, as appropriate, to get community input in the design and implementation of GEM.

3. Participate, in coordination with the Tribes, in various GEM meetings and workshops.

4. Help develop additional research and monitoring ideas outside of GEM to meet community interests in resource stewardship.

5. Assist in building the technical natural resource capacity at the community level.

6. Assist the Tribal Natural Resource Program Planner in communicating findings and results of relevant EVOS research to the Natural Resource Specialists.

NEED FOR THE PROJECT

A. Statement of Problem

Marine bird, fish and mammal stocks are believed to be profoundly influenced by the marine environment that hosts them and the food webs that support their production. Variations in annual production and species composition associated with cycles and shifts in ocean climate have been documented. To meet the mission of GEM, the physical condition of the northern Gulf of Alaska and selected target populations must be carefully tracked through time. The emerging "historical records" provide important insight about how the ecosystem responds to environmental fluctuations on scales from weeks and months to decades and ideally centuries. GEM monitoring will be strengthened significantly by the addition of coastal observations in the many sub-environments stretching from Prince William Sound to the Alaska Peninsula. There is a critical need to establish a long-term observational program in coastal waters because the edge-

zone of the northern Gulf is used by many sport, subsistence and commercial resources as reproductive and nursery habitat.

In addition, the *Exxon Valdez* oil spill caused severe disruption of the lives of many people living in the spill impacted area. The oil 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. Tribal members have expressed a desire for additional involvement in the restoration process, and voiced concern over incomplete communication to spill area inhabitants of study proposals and results. While the past several years have facilitated an increasing amount of communication between the scientists and the communities, there still exists a void for meaningful involvement in the restoration process by the community members at the grass roots level. 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.

In addition, communities in the spill area are very concerned about the long-term stewardship and management of lands and resources important to their subsistence way of life. These communities have been developing their Tribal Natural Resource Programs at the local level to ensure long-term health of injured oil spill species, important subsistence resources, and responsible management of lands in proximity to their villages and traditional use areas. The Gulf Ecosystem Monitoring Plan is also very concerned with the ecosystem and coordination between the communities and the Trustee Council regarding community-based monitoring and will be necessary to effectively monitor and document change in the Gulf of Alaska ecosystem.

Furthermore, the EVOS Trustee Council has recognized the need to increase communication and community involvement in the restoration process. This was stressed throughout the GEM Workshop, held in Anchorage in October 2000. The National Research Council also cited the need for meaningful community involvement in the interim report submitted by the Committee to Review the Gulf of Alaska Ecosystem Monitoring Program entitled *The Gulf Ecosystem Monitoring Program: First Steps Toward a Long-Term Research and Monitoring Plan, February 2001*. During the Public Advisory Group's April 4, 2001 meeting, the integration of community involvement into the GEM Program was identified as a top priority.

Therefore, it is evident that the integration of Tribes, their Natural Resource Programs, community research and monitoring, and GEM must take place in order to ensure meaningful community involvement in the GEM Program. The specifics of how this will occur must be defined by the communities and presented to the Trustee Council.

B. Rationale/Link to Restoration

This project furthers the Trustee Council's goals of facilitating the involvement of spill area residents and resource users in the restoration process and ensuring the long-term stewardship of marine resources. It also reaffirms the Trustee Council's dedication to the involvement of people living in the oil spill affected areas in the restoration and research and monitoring process.

In addition, 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 enhance the success of restoration efforts. Local people have expressed a desire to be involved in all aspects of restoration, and a willingness to work with researchers. The Tribes in the Chugach Region and the Ouzinkie Tribe are in the process of developing Tribal Natural Resource Plans. These plans are leading the way for the creation of methods and projects that will ensure the continued abundance of subsistence resources important to their communities. Tatitlek's plan was completed in FY 01, three other plans (Eyak, Port Graham, Nanwalek) are in draft form, and Ouzinkie's plan has not yet been drafted.

These plans form the basis for development of Tribal Natural Resource Programs. The Tribal Natural Resource Plans outline overall interests of the communities, including economic development, traditional use area management, and various other aspects of their Natural Resource Programs. The Chugach Tribes are also currently working with the Chugach Regional Resources Commission to develop an Inter-Tribal Integrated Natural Resource Stewardship Plan. This plan will coordinate all the Tribal Natural Resource Plans to provide a format for the Tribes to work cooperatively to address issues related to management, monitoring and research of their traditional use areas. Both the Tribal Natural Resource Plans and the Inter-Tribal Integrated Natural Resource Stewardship Plan will be instrumental in planning for participation in the GEM community-based research and monitoring programs. GEM must integrate local Tribal Natural Resource Plans and programs into the overall GEM Program to effectively monitor environmental conditions and indicator species. This project will open communication lines and help facilitate the interaction between the different entities.

At present, the only systematic and year-round monitoring program of ocean conditions in the northern Gulf of Alaska is maintained in outer Resurrection Bay by the Institute of Marine Science, University of Alaska Fairbanks (GAK-1 station) and in Cook Inlet, by Cook Inlet Keeper. Some seasonal records of temperature and plankton volumes have also been made over the years by aquaculture corporations in Prince William Sound, lower Cook Inlet, and Kodiak. These observations, coupled with those undertaken by several private organizations in the region, provide evidence that citizen monitors can be important contributors to long-term programs, but also demonstrate that to be effective, these efforts must be standardized and coordinated over time, which can be accomplished through the GEM Program. Furthermore, resource managers will benefit greatly from any new information arising from GEM and other coastal monitoring programs, such as information and data generated by the Tribes.

C. Location

This project will be spill area wide. All communities will have some level of involvement, based upon their needs and interests. In FY 02, five communities will be pilot project communities. These are Eyak, Nanwalek, Ouzinkie, Port Graham, and Tatitlek. Chenega Bay, Chignik Lake, Qutekcak, Seldovia, and Valdez will continue their involvement through their local governing bodies. Other regional, Native, and community organizations will be encouraged to participate and mold the parameters for the monitoring programs. Tribal Natural Resource Program development efforts may expand to other communities as the five pilots communities move

forward. The idea is to use the five pilot communities as models for other interested communities.

The project's benefits will be realized both in meaningful involvement by the communities and their Tribal Natural Resource Programs, and in the restoration of the injured resources. Better communication among the Trustee Council staff, researchers, and residents of the communities impacted by the spill should improve the effectiveness of restoration efforts and the GEM Program.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

The core of this project is the incorporation of community involvement and traditional knowledge into the EVOS restoration process and the GEM Program. Communities will be informed of EVOS projects and research findings, and provide input into the Trustee Council process through a network of Tribal Natural Resource Specialists, the Tribal Natural Resource Program Planner, TEK Specialist, Principal Investigator, and Science Advisor. The Natural Resource Specialists will be hired locally.

PROJECT DESIGN

A. Objectives

The objectives of the project will be to:

1. Complete the Tribal Natural Resource Plans for the five pilot communities. In the case of Tatitlek, where the plan is complete, complete the action plans (i.e., implementation plan) for some specific marine species listed in the plan.

2. Complete the Inter-Tribal Integrated Natural Resource Stewardship Plan, the regional plan for the Chugach/lower Cook Inlet region.

3. Facilitate community input into GEM

4. Compare the research parameters of the GEM Program to the Tribal Natural Resource Plans, to identify where their interests in research and monitoring overlap. This information will then be used to identify ways that the EVOS Trustee Council and the Tribes can work together in order to meet their common objectives.

5. Further develop the tribal technical management capacity of the Tribal Natural Resource Program personnel through participation in technical workshops and training sessions.

6. Improve the communication of findings and results of EVOS research to spill area Village Councils, inhabitants and the appropriate regional organizations. It is expected that by doing so, this project will increase the effectiveness of overall restoration efforts.

B. Methods

All project objectives will be achieved through the collaborative work of the PI, the Tribal Natural Resource Program Planner, the Natural Resource Specialists, the Tribal Natural Resource Programs, the TEK Specialist, and the Science Advisor.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

ADF&G will contract with CRRC for overall coordination of a network of Natural Resource Specialists through a Tribal Natural Resource Program Planner. Additionally, CRRC will contract with Dr. Henry Huntington to serve as the TEK specialist, and with other science advisors (not yet unidentified) as needed.

SCHEDULE

A. Measurable Project Tasks for FY 02 (October 1, 2001 - September 30, 2002)

NOTE: With the exception of some workshop travel in early 2002, this project was not authorized to begin until March 2002.

March 2002:	Contract with CRRC and ADF&G renewed
March 2002:	MOU renewed between ADF&G & CRRC
March 2002:	Advertise and hire Tribal Natural Resource Program Planner
March 2002:	Subcontracts with Tribes for Natural Resource Specialists renewed.
April 2002:	Contract with TEK Specialist renewed.
April 2002:	Contract with Science Advisor developed and signed.
January 2002:	Participate in EVOS Restoration Workshop
February 2002	Attend Region X EPA Environmental Conference and Alaska Forum on the Environment Conference
March 2002:	Attend BIA Integrated Resource Management Program Development Conference.
May 2002:	Attend the Native American Fish & Wildlife Society Conference.
September 2002:	Complete work on Tribal Natural Resource Plans for Eyak, Port Graham, Nanwalek, and Ouzinkie
September 2002:	Complete Inter-Tribal Integrated Natural Resource Stewardship Plan
September 2002:	Complete Tatitlek Tribal Action Plans for specific marine species
Ongoing:	Participate in GEM planning meetings and workshops, as well as capacity-building and training activities, as the opportunities arise

B. Project Milestones and Endpoints

March 2002:	Contracts with Tribes in place.
January 2002:	Attend EVOS Restoration Workshop.

September 2002:	Ouzinkie, Port Graham, Nanwalek, and Eyak Tribal Natural Resource Plans completed. Inter-Tribal Integrated Natural Resource Stewardship Plan completed. Some Tatitlek species-specific action plans completed.
April 2003:	Annual report submitted to EVOS.

C. Completion Date

Since the objective of this project is to integrate GEM with the Tribal Natural Resource Programs, we believe this program should be continued throughout the restoration, research, and monitoring process.

PUBLICATIONS AND REPORTS

An annual report will be submitted by CRRC by April 15th, 2003.

PROFESSIONAL CONFERENCES

The Tribal Natural Resource Specialists, Tribal Natural Resource Program Planner, TEK Specialist, Science Advisor, and Principal Investigator will be attending the Native American Fish & Wildlife Society Conference, which will be held in Anchorage, May 2002. The Conference will focus on community planning, natural resource monitoring, stewardship and how to integrate these initiatives with other research and monitoring efforts. This Conference will provide an excellent opportunity for the communities to examine other Tribal Natural Resource Programs and talk with people who are recognized as community involvement and community monitoring experts. Furthermore, Ms. Patty Brown-Schwalenberg, the Principal Investigator, plans to give a presentation at the conference on the Community Involvement Project, Traditional Knowledge, and the Tribes' role in the upcoming GEM Program.

NORMAL AGENCY MANAGEMENT

Not applicable.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project is an effort to GEM with the Tribal Natural Resource Programs and builds on the established relationship between CRRC and the communities in Prince William Sound. Other organizations may be included, such as the Cook Inlet Keeper, Regional Citizen Advisory Councils, Kachemak Bay Research Reserve, Alaska Wilderness Recreation and Tourism Association, and various others.

CRRC is contributing a considerable amount of in-kind services to the project. CRRC's Tribal Natural Resource Program development project has been operating for the past three years in four of the villages in the Chugach Region (Tatitlek, Port Graham, Nanwalek, and Cordova (Eyak)) and Ouzinkie. CRRC, through a BIA contract, is providing technical assistance in the villages to develop their Natural Resource Programs. The Native American Fish & Wildlife Society will be providing training and technical assistance through their Regional Conference and technical workshops. Part of the normal duties of the Natural Resource Specialists will be to collect traditional harvest and other baseline data (such as population assessments) on the resources in their traditional use areas.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

In FY 02, this project will shift its focus from community involvement to the integration of Tribal Natural Resource Programs with the Gulf Ecosystem Monitoring and Research Program (GEM).

PROPOSED PRINCIPAL INVESTIGATOR

Patty Brown-Schwalenberg, Executive Director
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4201 Tudor Centre Drive, Suite 300
Anchorage, Alaska 99508
Phone: 907-562-6647
Fax: 907-562-4939
Email: alutiiqpride@acsalaska.net

PRINCIPAL INVESTIGATOR

Patty Brown-Schwalenberg: Ms. Brown is the Executive Director of the Chugach Regional Resources Commission (CRRC) since 1994. She assists the Chugach Region Tribes in developing their Tribal natural resource programs, developing projects that stimulate the local community economy, and addressing issues and concerns directly related to subsistence and natural resources. She has worked for the past 19 years in such positions as Tribal Administrator for her Tribe, the Lac du Flambeau Band of Lake Superior Chippewa Indians, Society Administrator for the Native American Fish & Wildlife Society, Office Manager of the Bering Sea Fisheries Development Fund, and as a private consultant, assisting Alaska Native Tribes in obtaining funding for natural resource programs, and setting up their natural resource program administrative systems. CRRC and the previous organizations that Ms. Brown has operated have consistently met all standards of proper management, including annual program and financial audits.

OTHER KEY PERSONNEL

Tribal Natural Resource Program Planner. The Tribal Natural Resource Program Planner position is vacant at this time. Please see attached position description for information on desired background and education.

Dr. Henry Huntington: CRRC has contracted with Dr. Huntington to serve as the TEK Specialist. Dr. Huntington received his Ph.D. at the University of Cambridge (U.K.), Scott Polar Research Institute in Polar Studies. He has served as the Environmental Coordinator for the Inuit Circumpolar Conference (ICC), coordinating ICC policy regarding the Arctic Environmental Protection Strategy (AEPS), in cooperation with indigenous organizations in Russia and Scandinavia. He was also responsible for traditional ecological knowledge and other research projects under the auspices of the AEPS.

Science Advisors: We previously contracted with Dr. Ted Cooney for these services, but logistically it has been a challenge trying to make travel arrangements since he lives in Montana. Therefore, we are currently working with the EVOS Restoration Office staff to identify others with similar qualifications residing in Alaska.

LITERATURE CITED

Exxon Valdez Oil Spill (EVOS) Trustee Council, "FY2001 Annual Workshop, October 12-13, 2000 Work Group Notes." Unpublished.

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National Research Council, The Gulf Ecosystem Monitoring Program: First Steps Toward a Long-Term Research and Monitoring Plan. Interim Report. February 2001. National Academy Press, Washington, D.C.

Revision 3-13-02
Approved TC 4-18-02

02052rev1.doc

Natural Resource Management and Stewardship Capacity Building

Project Number:	02052
Restoration Category:	General Restoration
Proposer:	P. Brown-Schwalenberg/CRRC
Lead Trustee Agency:	ADFG
Cooperating Agencies:	None
Alaska SeaLife Center:	No
New or Continued:	Continued
Duration:	8th year, 8 year project
Cost FY 02:	$131,400
Geographic Area:	All
Injured Resource/Service:	Subsistence

4/22/02
Cherri –
Recently approved DPDs – add to FY 02 DPD/ Budget binder in admin. Record. I (will) need copies back today, please.) Thanks, S

ABSTRACT

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completing an Inter-T
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workshops. The long
stewardship of marine

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New or Continued:	Continued
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Cost FY 02:	$131,400
Geographic Area:	All
Injured Resource/Service:	Subsistence

ABSTRACT

In FY 02, this project will shift its focus from community involvement to the integration Tribal Natural Resource Management Programs with the Gulf Ecosystem Monitoring and Research Program (GEM). Communities involved in the project include those in the Alaska Peninsula Region/Chignik Lake, Chenega Bay, Cordova (Eyak), Kodiak Island Region/Ouzinkie, Nanwalek, Port Graham, Seward (Qutekcak), Seldovia, Tatitlek, and Valdez. In FY 02, project will focus on three objectives: (a) completing Tribal Natural Resource Management Plans in five pilot communities (Tatitlek, Eyak (Cordova), Port Graham, Nanwalek, and Ouzinkie), (b) completing an Inter-Tribal Integrated Natural Resource Management Plan for the Chugach/Lower Cook Inlet region, and (c) actively participating in GEM planning meetings and workshops. The long-term goal of the Trustee Council contribution to the project is local stewardship of marine resources.

INTRODUCTION

In FY 02, this project will shift its focus from community involvement to the integration of Tribal Natural Resource Programs with the Gulf Ecosystem Monitoring Program. The project is designed to enhance the stewardship capacity of the Alaska Native community in the spill region. and This project will examine the communities' interests, priorities and activities through their Tribal Natural Resource Programs and how these relate to the GEM Program. Candidate projects emerging from our planning effort will exhibit a blend of modern measurement science and traditional observation, which will be beneficial to both the GEM Program and the Tribal Natural Resource Programs.

After a pilot effort beginning in three communities in FY 95, ten Community Facilitators were hired in FY 97 through cooperative agreements with the Village Councils of Chenega Bay, Chignik Lake (Alaska Peninsula Region), Eyak (Cordova), Nanwalek, Ouzinkie (Kodiak Island Region), Port Graham, Qutekcak (Seward), Seldovia, Tatitlek, and Valdez to involve communities in the EVOS restoration process. The Spill Area Wide Community Involvement Coordinator worked with the Community Facilitators to promote communication among the EVOS Trustee Council, the communities, and scientists. Their efforts continued through FY 00 and FY 01 while five pilot communities (Cordova, Nanwalek, Ouzinkie, Port Graham, and Tatitlek) also began development of Tribal Natural Resource Management Plans, designed to assist the communities in having a more active role in GEM. These pilot communities were funded at a higher level for the additional work required.

In FY 00, workshops were held to further develop the technical capacity of the communities in the Chugach Region and spill area. This increased capacity is a key component in their efforts to ensure the sustainability of their subsistence resources. One workshop was held in December 2000 between the village corporations and Tribes to discuss ways of cooperatively managing village corporation lands. Additionally, the corporations and Tribes in Prince William Sound have been working extensively with the United States Forest Service to ensure their involvement in the Chugach National Forest Management Plan Revision currently underway. Cooperative and collaborative management of lands and resources have been actively discussed and strategies for further developing a formal relationship are underway. In FY 00, the pilot communities, as well as members of the CRRC Board, traveled to Lac du Flambeau, Wisconsin to observe the Tribal natural resource research and monitoring program currently being conducted by the Lac du Flambeau Band of Lake Superior Chippewa Indians. This trip was an effort to provide the communities with an opportunity to experience first hand a model Tribal Natural Resource Management Program, which could perhaps serve as a model for programs in the spill area. This trip also served to encourage more Tribal involvement in the community research and monitoring aspects of the GEM Plan.

In FY 01, the CRRC Board of Directors held a Strategic Planning Session. During this meeting they identified Tribal Natural Resource Management Plan development along with an EVOS $20 million Tribal Community Fund as top priorities of CRRC. The Board of Directors also prioritized the communities' involvement in GEM and community involvement/Traditional Ecological Knowledge, indicating their interest in remaining involved in the EVOS process. In October of 2000, project personnel (the Community Facilitators, Natural Resource Specialists,

Science Advisor, Principal Investigator, TEK Specialist, and Spill Area Wide Community Involvement Coordinator) all participated in the Trustee Council's GEM Workshop, advocating for meaningful community involvement and TEK being incorporated into the GEM Plan/Program.

In March 2001, the Principal Investigator and Spill Area Wide Community Involvement Coordinator, in cooperation with the Chugach Alaska Corporation, Chugachmiut, and North Pacific Rim Housing Authority, organized the Chugach Regional Summit on Natural Resources for participation by the Board of Directors of the Chugach Region Native Corporations, Tribal Councils, and regional organizations. The Community Facilitators and Natural Resource Specialists also participated. During this Summit the communities identified barriers, and developed solutions, for the Tribal Natural Resource Management Programs and discussed ways to assist in creating cooperative relationships between the Tribes, Native corporations, and state and federal management agencies in the area of jurisdiction, enforcement and management of natural resources. Meetings were held in Nanwalek and Port Graham to explore these opportunities that resulted in cooperative projects being developed for submission to the Federal Subsistence Board.

In FY 02, specific project tasks will be (a) completing Tribal Natural Resource Management Plans in five pilot communities (Tatitlek, Eyak (Cordova), Port Graham, Nanwalek, and Ouzinkie), (b) completing an Inter-Tribal Integrated Natural Resource Management Plan for the Chugach/Lower Cook Inlet region, and (c) actively participating in GEM planning meetings and workshops. In addition, the Tribes will work to further develop their technical capacity to conduct research and monitoring projects under the GEM program and to identify common areas of interest between the Tribal Natural Resource Programs and GEM. Once these common areas of interest are identified, the goal will be to develop methods by which Tribes can assume specific research and monitoring activities of GEM, while leveraging other funds to implement other aspects of their Tribal Natural Resource Management Plans.

In FY 02, the position of Spill Area Wide Community Involvement Coordinator will be replaced with a Tribal Natural Resource Program Planner. This person (to be hired) will be responsible for coordinating the overall project out of the Restoration and CRRC offices, to accomplish the following tasks:

1. Continue the involvement of community members and Tribal Natural Resource Management Programs throughout the spill region in development of the GEM Program. This will include active participation of the Tribal Natural Resource Program Planner and Tribal representatives in various GEM planning meetings and workshops, such as the January 2002 EVOS Annual Workshop and the intertidal workshop to be held in Homer in April.

2. Serve as contact point for natural resource personnel in each of ten participating communities (Alaska Peninsula Region/Chignik Lake, Chenega Bay, Cordova, Kodiak Island Region/Ouzinkie Nanwalek, Port Graham, Seldovia, Seward, Tatitlek, and Valdez). The Tribal Natural Resource Program Planner will:

a. Coordinate and assist in the completion of Tribal Natural Resource Management Plans in the five pilot communities and incorporate individual plan information into an Inter-Tribal Integrated Natural Resource Management Plan.
b. Coordinate the participation of the Tribes in the EVOS annual restoration workshop and various GEM planning meetings and workshops.
c. Work with the TEK Specialist (see below) to facilitate participation of natural resource personnel in capacity building efforts (e.g., training sessions, workshops, conferences).

3. Communicate findings and results of relevant EVOS research to the Natural Resource Specialists.

4. Provide input at Restoration Work Force and Public Advisory Group meetings.

5. Attend (in person or by teleconference) all Trustee Council meetings and report to the Tribes on relevant actions taken.

6. Prepare quarterly project status reports and an annual project report, as required by the Trustee Council's reporting procedures.

Trustee Council funding will support roughly one-quarter time of an existing Natural Resource Specialist (or similar position) in each of the five pilot communities. The specific tasks to be undertaken by the Natural Resource Specialists include the following:

1. Complete Tribal Natural Resource Management Plans and begin work, if possible, on action (i.e., implementation) plans. The current status of the plans is as follows:

2. Participate in completion of an Integrated Inter-Tribal Natural Resource Management Plan. This plan, which addresses the Chugach/lower Cook Inlet region, is currently in its third draft.

Tatitlek: Plan completed. Next step is to prepare species-specific action plans. MOA with Tatitlek Corporation is in place regarding Tribal management of resources.
Eyak (Cordova): First draft of plan is done.
Port Graham: Third draft of plan is done. MOA with Port Graham Corporation is in place regarding Tribal management of resources.
Nanwalek: First draft of plan is done.
Ouzinkie: Plan not yet drafted.

3. Participate in the EVOS Annual Restoration Workshop, various GEM planning meetings and workshops, the Native American Fish & Wildlife Society Conference, Alaska Forum on the Environment conference, and the EPA Region X environment management conference.

4. Work with project staff to identify common areas of interest between the Tribal Natural Resource Management Plans and the GEM Program.

5. Continue building the technical natural resource capacity at the community level through participation in training and education opportunities, including research and monitoring techniques.

6. Inform the Tribal Natural Resource Program Planner of community issues, concerns, or questions regarding GEM. These issues could be identified through community meetings or through other means, and could include ideas for integrating GEM and the Tribal Natural Resource Management Plans.

7. Coordinate any activities that have a direct impact on the local community resources and any research projects that will complement the Tribe's traditional knowledge of the traditional use areas.

In addition, Project 02052 will support travel necessary for participation of other communities (Chenega Bay, Valdez, Seldovia, Seward (Qutekcak), Chignik Lake) in the spill region in various GEM planning meetings and workshops and in capacity-building activities (e.g., training and workshops).

The specific tasks for the Traditional Ecological Knowledge (TEK) Specialist will be to:

1. Assist the Tribal Natural Resource Programs with completion of their Tribal Natural Resource Management Plans, specifically in the areas of traditional ecological knowledge.

2. Assist spill area communities as requested, in developing methods for documenting TEK and otherwise incorporating it into research and monitoring programs related to GEM.

3. Provide other assistance as necessary to the project and to the Tribal Natural Resource Program Planner.

The specific tasks for other science advisors will be to:

1. Work with the communities to identify GEM related projects within their Tribal Natural Resource Management Plans.

2. Coordinate community input in the GEM program, including serving as the liaison with other GEM scientists, as appropriate, to get community input in the design and implementation of GEM.

3. Participate, in coordination with the Tribes, in various GEM meetings and workshops.

4. Help develop additional research and monitoring ideas outside of GEM to meet community interests in resource stewardship.

5. Assist in building the technical natural resource capacity at the community level.

6. Assist the Tribal Natural Resource Program Planner in communicating findings and results of relevant EVOS research to the Natural Resource Specialists.

NEED FOR THE PROJECT

A. Statement of Problem

Marine bird, fish and mammal stocks are believed to be profoundly influenced by the marine environment that hosts them and the food-webs that support their production. Variations in annual production and species composition associated with cycles and shifts in ocean climate have been documented. To meet the mission of GEM, the physical condition of the northern Gulf of Alaska and selected target populations must be carefully tracked through time. The emerging "historical records" provide important insight about how the ecosystem responds to environmental fluctuations on scales from weeks and months to decades and ideally centuries. GEM monitoring will be strengthened significantly by the addition of coastal observations in the many sub-environments stretching from Prince William Sound to the Alaska Peninsula. There is a critical need to establish a long-term observational program in coastal waters because the edge-zone of the northern Gulf is used by many sport, subsistence and commercial resources as reproductive and nursery habitat.

In addition, the *Exxon Valdez* oil spill caused severe disruption of the lives of many people living in the spill impacted area. The oil 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 voiced concern over a lack of involvement by spill area communities in the restoration efforts, and incomplete communication to spill area inhabitants of study proposals and results. While the past several years have facilitated an increasing amount of communication between the scientists and the communities, there still exists a void for meaningful involvement in the restoration process by the community members at the grass roots level. 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.

In addition, communities in the spill area are very concerned about the long-term stewardship and management of lands and resources important to their subsistence way of life. These communities have been developing their Tribal Natural Resource Management Programs at the local level to ensure long-term health of injured oil spill species, important subsistence resources, and responsible management of lands in proximity to their villages and traditional use areas. The Gulf Ecosystem Monitoring Plan is also very concerned with the ecosystem and coordination between the communities and the Trustee Council regarding community-based monitoring and will be necessary to effectively monitor and document change in the Gulf of Alaska ecosystem.

Furthermore, the EVOS Trustee Council has recognized the need to increase communication and community involvement in the restoration process. This was stressed throughout the GEM Workshop, held in Anchorage in October 2000. The National Research Council also sited the need for meaningful community involvement in the interim report submitted by the Committee to Review the Gulf of Alaska Ecosystem Monitoring Program *entitled The Gulf Ecosystem Monitoring Program: First Steps Toward a Long-Term Research and Monitoring Plan, February 2001*. During the Public Advisory Group's April 4, 2001 meeting, the integration of community involvement into the GEM Program was identified as a top priority.

Therefore, it is evident that the integration of Tribes, their Natural Resource Programs, community research and monitoring, and GEM must take place in order to ensure meaningful community involvement in the GEM Program. The specifics of how this will occur must be defined by the communities and presented to the Trustee Council.

B. Rationale/Link to Restoration

This project furthers the Trustee Council's goals of facilitating the involvement of spill area residents and resource users in the restoration process and ensuring the long-term stewardship of marine resources. It also reaffirms the Trustee Council's dedication to the involvement of people living in the oil spill affected areas in the restoration and research and monitoring process.

In addition, 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 enhance the success of restoration efforts. Local people have expressed a desire to be involved in all aspects of restoration, and a willingness to work with researchers. The Tribes in the Chugach Region and the Ouzinkie Tribe are in the process of developing Tribal Natural Resource Management Plans. These plans are leading the way for the creation of methods and projects that will ensure the continued abundance of subsistence resources important to their communities. Tatitlek's plan was completed in FY 01, three other plans (Eyak, Port Graham, Nanwalek) are in draft form, and Ouzinkie's plan has not yet been drafted.

These Plans form the basis for development of Tribal Natural Resource Management Programs. The Tribal Natural Resource Management Plans outline overall interests of the communities, including economic development, traditional use area management, and various other aspects of their Natural Resource Management Programs. The Chugach Tribes are also currently working with the Chugach Regional Resources Commission to develop an Inter-Tribal Integrated Natural Resource Management Plan. This plan will coordinate all the Tribal Plans to provide a format for the Tribes to work cooperatively to address issues related to management, monitoring and research of their traditional use areas. Both the Tribal plans and the Inter-Tribal Integrated Natural Resource Management Plan will be instrumental in planning for participation in the GEM community-based research and monitoring programs. GEM must integrate local Tribal Natural Resource Management Plans and Programs into the overall GEM Program to effectively monitor environmental conditions and indicator species. This project will open communication lines and help facilitate the interaction between the different entities.

At present, the only systematic and year-round monitoring program of ocean conditions in the northern Gulf of Alaska is maintained in outer Resurrection Bay by the Institute of Marine Science, University of Alaska Fairbanks (GAK-1 station) and in Cook Inlet by Cook Inlet Keeper. Also, some seasonal records of temperature and plankton volumes have been made over the years by aquaculture corporations in Prince William Sound, lower Cook Inlet, and at Kodiak. These observations, coupled with those undertaken by several private organizations in the region, provide evidence that citizen monitors can be important contributors to long-term programs, but also demonstrate that to be effective, these efforts must be standardized and coordinated over time, which can be accomplished through the GEM Program. Furthermore, resource managers will benefit greatly from any new information arising from GEM and other coastal monitoring programs, such as information and data generated by the Tribes.

C. Location

This project will be spill area wide. All communities will have some level of involvement, based upon their needs and interests. In FY 02, five communities will be pilot project communities. These are Eyak, Nanwalek, Ouzinkie, Port Graham, and Tatitlek. Chenega Bay, Chignik Lake, Qutekcak, Seldovia, and Valdez will continue their involvement through their local governing bodies. Other regional, Native, and community organizations will be encouraged to participate and mold the parameters for the monitoring programs. Tribal Natural Resource Management Program development efforts may expand to other communities as the five pilots communities move forward. The idea is to use the five pilot communities as models for other interested communities.

The project's benefits will be realized both in meaningful involvement by the communities and their Tribal Natural Resource Management Programs, and in the restoration of the injured resources. Better communication among the Trustee Council staff, researchers, and residents of the communities impacted by the spill should improve the effectiveness of restoration efforts and the GEM Program.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

The core of this project is the incorporation of community involvement and traditional knowledge into the EVOS restoration process and the GEM Program. Communities will be informed of EVOS projects and research findings, and provide input into the Trustee Council process through a network of Tribal Natural Resource Specialists, the Tribal Natural Resource Program Planner, TEK Specialist, Principal Investigator, and Science Advisor. The Natural Resource Specialists will be hired locally.

PROJECT DESIGN

A. Objectives

The objectives of the project will be to:

1. Complete the Tribal Natural Resource Management Plans for the five pilot communities. In the case of Tatitlek, where the plan is complete, complete the action plans (i.e,. implementation plan) for some specific marine species listed in the management plan.

2. Complete the Inter-Tribal Integrated Natural Resource Management Plan, the regional plan for the Chugach/lower Cook Inlet region.

3. Facilitate community input into GEM

4. Compare the research parameters of the GEM Program to the Tribal Natural Resource Management Plans, to identify where their interests in research and monitoring overlap. This information will then be used to identify ways that the EVOS Trustee Council and the Tribes can work together in order to meet their common objectives.

5. Further develop the tribal technical management capacity of the Tribal Natural Resource Management Program personnel through participation in technical workshops and training sessions.

6. Improve the communication of findings and results of EVOS research to spill area Village Councils, inhabitants and the appropriate regional organizations. It is expected that by doing so, this project will increase the effectiveness of overall restoration efforts.

B. Methods

All project objectives will be achieved through the collaborative work of the PI, the Tribal Natural Resource Program Planner, the Natural Resource Specialists, the Tribal Natural Resource Management Programs, the TEK Specialist, and the Science Advisor.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

ADF&G will contract with CRRC for overall coordination of a network of Natural Resource Specialists through a Tribal Natural Resource Program Planner. Additionally, CRRC will contract with Dr. Henry Huntington to serve as the TEK specialist, and with other science advisors (not yet unidentified) as needed.

SCHEDULE

A. Measurable Project Tasks for FY 02 (October 1, 2001 - September 30, 2002)
NOTE: With the exception of some workshop travel in early 2002, this project was not authorized to begin until March 2002.

March 2002:	Contract with CRRC and ADF&G renewed
March 2002:	MOU renewed between ADF&G & CRRC
March 2002:	Advertise and hire Tribal Natural Resource Program Planner

March 2002:	Subcontracts with Tribes for Natural Resource Specialists renewed.
April 2002:	Contract with TEK Specialist renewed.
April 2002:	Contract with Science Advisor developed and signed.
January 2002:	Participate in EVOS Restoration Workshop
February 2002	Attend Region X EPA Environmental Conference and Alaska Forum on the Environment Conference
March 2002:	Attend BIA Integrated Resource Management Program Development Conference.
May 2002:	Attend the Native American Fish & Wildlife Society Conference.
September 2002:	Complete work on Tribal Natural Resource Management Plans for Eyak, Port Graham, Nanwalek, and Ouzinkie
September 2002:	Complete Inter-Tribal Integrated Natural Resource Management Plan
September 2002:	Complete Tatitlek Tribal Action Plans for specific marine species
Ongoing:	Participate in GEM planning meetings and workshops, as well as capacity-building and training activities, as the opportunities arise

B. Project Milestones and Endpoints

March 2002:	Contracts with Tribes in place.
January 2002:	Attend EVOS Restoration Workshop.
September 2002:	Ouzinkie, Port Graham, Nanwalek, and Eyak Tribal Natural Resource Management Plans completed. Inter-Tribal Integrated Natural Resource Management Plan completed. Some Tatitlek species-specific action plans completed.
April 2003:	Annual report submitted to EVOS.

C. Completion Date

Since the objective of this project is to integrate GEM with the Tribal Natural Resource Management Programs, we believe this program should be continued throughout the restoration, research, and monitoring process.

PUBLICATIONS AND REPORTS

An annual report will be submitted by CRRC by April 15th, 2003.

PROFESSIONAL CONFERENCES

The Tribal Natural Resource Specialists, Tribal Natural Resource Program Planner, TEK Specialist, Science Advisor, and Principal Investigator will be attending the Native American Fish & Wildlife Society Conference, which will be held in Anchorage, May 2002. The

Conference will focus on community planning, natural resource monitoring, stewardship and how to integrate these initiatives with other research and monitoring efforts. This Conference will provide an excellent opportunity for the communities to examine other Tribal Natural Resource Management Programs and talk with people who are recognized as community involvement and community monitoring experts. Furthermore, Ms. Patty Brown-Schwalenberg, the Principal Investigator, plans to give a presentation at the conference on the Community Involvement Project, Traditional Knowledge, and the Tribes' role in the upcoming GEM Program.

NORMAL AGENCY MANAGEMENT

Not applicable.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project is an effort to GEM with the Tribal Natural Resource Management Programs and builds on the established relationship between CRRC and the communities in Prince William Sound. Other organizations may be included, such as the Cook Inlet Keeper, Regional Citizen Advisory Councils, Kachemak Bay Research Reserve, Alaska Wilderness Recreation and Tourism Association, and various others.

CRRC is contributing a considerable amount of in-kind services to the project. CRRC's Tribal Natural Resource Management Program development project has been operating for the past three years in four of the villages in the Chugach Region (Tatitlek, Port Graham, Nanwalek, and Cordova (Eyak)) and Ouzinkie. CRRC, through a BIA contract, is providing technical assistance in the villages to develop their Management Programs. The Native American Fish & Wildlife Society will be providing training and technical assistance through their Regional Conference and technical workshops. Part of the normal duties of the Natural Resource Specialists will be to collect traditional harvest and other baseline data (such as population assessments) on the resources in their traditional use areas.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

In FY 02, this project will shift its focus from community involvement to the integration of Tribal Natural Resource Management Programs with the Gulf Ecosystem Monitoring and Research Program (GEM).

PROPOSED PRINCIPAL INVESTIGATOR

Patty Brown-Schwalenberg, Executive Director
Chugach Regional Resources Commission
4201 Tudor Centre Drive, Suite 300

Anchorage, Alaska 99508
Phone: 907-562-6647
Fax: 907-562-4939
Email: alutiiqpride@acsalaska.net

PRINCIPAL INVESTIGATOR

Patty Brown-Schwalenberg: Ms. Brown is the Executive Director of the Chugach Regional Resources Commission (CRRC) since 1994. She assists the Chugach Region Tribes in developing their Tribal natural resource programs, developing projects that stimulate the local community economy, and addressing issues and concerns directly related to subsistence and natural resources. She has worked for the past 19 years in such positions as Tribal Administrator for her Tribe, the Lac du Flambeau Band of Lake Superior Chippewa Indians, Society Administrator for the Native American Fish & Wildlife Society, Office Manager of the Bering Sea Fisheries Development Fund, and as a private consultant, assisting Alaska Native Tribes in obtaining funding for natural resource management programs, and setting up their natural resource program administrative systems. CRRC and the previous organizations that Ms. Brown has operated have consistently met all standards of proper management, including annual program and financial audits.

OTHER KEY PERSONNEL

Tribal Natural Resource Program Planner. The Tribal Natural Resource Program Planner position is vacant at this time. Please see attached position description for information on desired background and education.

Dr. Henry Huntington: CRRC has contracted with Dr. Huntington to serve as the TEK Specialist. Dr. Huntington received his Ph.D. at the University of Cambridge (U.K.), Scott Polar Research Institute in Polar Studies. He has served as the Environmental Coordinator for the Inuit Circumpolar Conference (ICC), coordinating ICC policy regarding the Arctic Environmental Protection Strategy (AEPS), in cooperation with indigenous organizations in Russia and Scandinavia. He was also responsible for traditional ecological knowledge and other research projects under the auspices of the AEPS.

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LITERATURE CITED

Exxon Valdez Oil Spill (EVOS) Trustee Council, "FY2001 Annual Workshop, October 12-13, 2000 Work Group Notes." Unpublished.

Exxon Valdez Oil Spill (EVOS) Trustee Council, "Exxon Valdez Oil Spill Public Advisory Group Meeting Summary." April 4, 2001. Unpublished.

National Research Council, The Gulf Ecosystem Monitoring Program: First Steps Toward a Long-Term Research and Monitoring Plan. Interim Report. February 2001. National Academy Press, Washington, D.C.

Revision 3-8-02
Approved TC 3-8-02

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$0.0						
Travel		$0.0						
Contractual		$122.8						
Commodities		$0.0						
Equipment		$0.0						
Subtotal	$0.0	$122.8	Estimated FY 2003					
General Administration		$8.6						
Project Total	$0.0	$131.4						
Full-time Equivalents (FTE)		0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY02

Prepared: 3/8/02

Project Number: 02052
Project Title: Natural Resource Mgmt. & Stewardship Capacity Building
Agency: ADF&G

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Revision 3/02

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel	$37.5	$40.0
Travel	$22.1	$20.0
Contractual	$110.0	$45.0
Commodities	$2.0	$1.8
Equipment		$0.0
Subtotal	$171.6	$106.8
Indirect	$17.1	$16.0
Project Total	$188.7	$122.8
Full-time Equivalents (FTE)	0.8	0.5
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 2003					
$0.0					

Dollar amounts are shown in thousands of dollars.

Comments:

ADF&G GA (7%) needs to be added to this budget: $122.8 + $8.6 = $131.4. Of this amount, $45.0 was approved by the Trustee Council 8/6/01. Balance for approval in April 2002 is $86.4.

Indirect - CRRC's indirect amount is 15%. This includes costs related to general office operation.
Annual Restoration Attendance - 6% of the Project Budget.
Professional Conferences - 6% of the Project Budget will go towards the Project Personnel's attendance at the Native American Fish & Wildlife Society Conference to be held in Anchorage in May 2002.
Community Involvement - 100% of the Project Budget.

CRRC and its member Tribes will also be providing in-kind contributions to this project (totaling $93,000),, as follows:

Tribal Natural Resource Personnel -	$20,000.00
Bureau of Indian Affairs funding support	43,000.00
GIS Mapping System	30,000.00

FY02

Prepared: 3/8/02

Project Number: 02052
Project Title: Natural Resource Mgmt. & Stewardship Capacity Building
Name: Chugach Regional Resources Commission

FORM 4A
Non-Trustee
SUMMARY

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2002
	To be Determined	Tribal Natural Resources Program Planner	6.0	6.6	0.0	40.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	6.0	6.6	0.0	
					Personnel Total	$40.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2002
	Travel for Natural Resource Personnel to attend mini-workshops, GEM meetings & workshops, NAFWS Conference, and the EVOS Restoration Workshop	0.5	20	80	0.1	18.0
	TEK Specialist/Nat. Res. Program Planner/Science Advisor					2.0
	Principle Investigator's travel throughout spill area					0.0
						0.0
					Travel Total	$20.0

FY02

Prepared: 3/8/02

Project Number: 02052
Project Title: Community Involvement Planning for GEM
Name: Chugach Regional Resources Commission

FORM 4B
Personnel
& Travel
DETAIL

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:	Proposed FY 2002
Description	
TEK Specialist & Science Advisor	20.0
Sub-contracts with Tribal Councils in spill area to provide facilitation services, participate in GEM planning and implementation, and other duties as outlined in the DPD (5 pilot communities at $5,000 each). Based on roughly one-quarter time for remaining 6 mo. of FY 02 (April-Sept) at roughly $15/hr. plus benefits.	25.0
Contractual Total	$45.0

Commodities Costs:	Proposed FY 2002
Description	
Incidental costs for workshops (meeting space rental, supplies, food, etc.)	1.8
Commodities Total	$1.8

FY02

Prepared: 3/8/02

Project Number: 02052
Project Title: Community Involvement Planning for GEM
Name: Chugach Regional Resources Commission

FORM 4B
Contractual & Commodities DETAIL

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2002
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	

FY02

Project Number: 02052
Project Title: Community Involvement Planning for GEM
Name: Chugach Regional Resources Commission

FORM 4B
Equipment
DETAIL

Prepared: 3/8/02

approved TC 12-11-01

Construction of a Linkage Map for the Pink Salmon Genome

Project Number:	02190
Restoration Category:	Research
Proposer:	Fred W. Allendorf University of Montana
Lead Trustee Agency:	ADFG
Alaska SeaLife Center:	No
Duration:	7th year, 8-year project
Cost FY 02:	$168,000
Cost FY 03:	$80,300
Geographic Area:	Prince William Sound
Injured Resource:	Pink salmon

ABSTRACT

We will complete the analysis of experiments conducted at the Alaska SeaLife Center (ASLC) that use the linkage map we have constructed to test for effects of regions of the genome on traits that are important to recovery of pink salmon (e.g., growth and survival). Sexually mature adults from the 1999 cohorts produced from wild pink salmon collected from Likes Creek are expected to return to Resurrection Bay and the ASLC in August and September 2001. We will compare genotypes in released fry and returning adults to test for genetic differences in marine survival and other life history traits (e.g., body size, egg number, and egg size).

INTRODUCTION

This is the final phase of our research to construct a genetic linkage map for pink salmon (*Oncorhynchus gorbuscha*) and to use this map to evaluate effects of natural selection on the genome of this species. Such a map was proposed initially to provide the necessary platform to identify genetic damage in pink salmon inhabiting oiled streams following the March 1989 *Exxon Valdez* oil spill (EVOS). We have conducted a series of experiments based at the Alaska SeaLife Center (ASLC) to identify regions of the genome that affect various organismal traits and to test for the effects of natural selection on regions of the genome that include markers used to describe genetic population structure. This research will aid recovery efforts with pink salmon, including estimation of straying rates, description of stock structure, and testing if marine survival and other organismal measures of phenotypic variation have a genetic basis.

Genetic linkage maps have provided the necessary information for understanding genetic variation in species since the rediscovery of Mendel's principles early in this century. A genetic map plays a similar role for a geneticist that a geographical map plays for the explorer of new territories. For many years, genetic maps could only be constructed in a very few model species that were suitable for extensive genetic manipulation (e.g., *Drosophila* and mice). Recent advances in molecular genetics now make it possible to uncover enough genetic markers to construct a detailed genetic linkage map in almost any species (Postlethwait et al. 1994).

This project began in FY 96. However, we did not receive authorization to proceed until half-way through FY 96 (March 1996). We have completed our two initial objectives that included identifying several hundred genetic markers and using them to construct a linkage map. We have used the ASLC for experiments that apply the linkage map to an understanding of the fundamental population biology and genetics of pink salmon.

This work was originally designed to support work with pink salmon under the project *Oil-Related Embryo Mortalities* (Restoration Study \191A). The objective of that project was to identify germline mutations in pink salmon exposed to oil. Genetic damage induced by oil may either be small changes in nucleotide sequence (microlesions) or large-scale changes in chromosome structure (macrolesions). A detailed genetic map for pink salmon would have been invaluable for interpreting the results of Restoration Study \191A in several ways. First, it would be possible by following the inheritance of any DNA lesions to determine if they are micro- or macro-lesions. Second, these lesions could be mapped to determine if they are randomly spread throughout the genome or if they occur at mutational "hot spots" that are susceptible to oil induced damage. However, Restoration Study \191A is no longer ongoing, and thus our future work will concentrate on our original Objectives 5 and 6 as described in this proposal.

We modified our proposal last year because we found high mutation rates at two microsatellite loci. These mutations are not randomly distributed among families, but some are "clustered" in certain families. The rates and especially the patterns of mutations that we have observed have provided some important fundamental insights into the evolution of microsatellite loci and their use in population genetic studies. Results with humans have found an increase in mutation rates at minisatellite loci following exposure to radiation following the Chernobyl

incident (Dubrova et al. 1996). Our recent results raise the possibility that microsatellite loci may also be good candidates for monitoring germline mutations in marine species following exposure to oil.

We are continuing our experiments at the ASLC to test for regions of the genome associated with marine survival and fitness. We released nearly 50,000 progeny in spring 1999, and anticipated a 2-5% return rate in our original experimental design. Due to the failure of the fish pass at the ASLC to attract returning marked adults we captured only 36 fish from nearby freshwater streams in Resurrection Bay. The collection of these fish from such a large system indicates that a substantial number of marked fish did survive and return to Resurrection Bay. We were not able to complete any of our objectives with the 1998 cohort because of the poor returns. We have adjusted our plans for recapturing returning adults from the 1999 cohort when they return to Resurrection Bay in the hopes of collecting an adequate sample for analysis.

NEED FOR THE PROJECT

A. Statement of Problem

Elevated embryo mortalities were detected in populations of pink salmon inhabiting oiled streams following the spill. These increased rates of mortality persisted through the 1993 field season, three generations after the oil spill, suggesting that genetic damage may have occurred as a result of exposure to oil during early developmental life-stages. The consequences of the putative genetic damage include impaired physiological function of individuals and reduced reproductive capacity of pink salmon populations (Bue et al. 1998).

The aggregate of evidence from field studies and incubation experiments suggests that embryos exposed to oil in 1989 and 1990 accumulated deleterious mutations in the germline (Bue et al. 1998). However, see Cronin and Bickham (1998) for an alternative interpretation of these data. This hypothesis of genetic damage is consistent with previous field observations and laboratory experiments on the effects of crude oil on early life stages of fish. Long term intra-gravel oil exposures (7-8 months) to freshly fertilized eggs provide embryos sufficient time to accumulate polynuclear aromatic hydrocarbons (PAH's) from very low aqueous concentrations of crude oil. PAH's are abundant in crude oil and are potent clastogens (i.e. capable of breaking chromosomes). Roy et al. (1999) have recently reported evidence of molecular genetic damage to pink salmon embryos exposed to crude oil.

Mironov (1969) observed reduced survival of fish embryos and larvae exposed to very low aqueous doses (1 ul oil/L seawater) of oil. Longwell (1977) reported genetic damage in pelagic embryos affected by the ArgoMerchant oil spill. Moles et al. (1987) confirmed that pink salmon embryos take up PAH's and demonstrated that the uptake was much greater in an intertidal environment than in strictly freshwater conditions. Biggs et al. (1991) found greater numbers of chromosome aberrations in larval herring that incubated in oiled areas than in non-oiled areas. It is likely that the same type of damage may have occurred in pink salmon and other species in Prince William Sound, and this damage could have affected the germline of exposed individuals

(Malkin 1994; Bue et al. 1998).

Molecular genetic techniques have been used extensively to describe population structure of Pacific salmon (Utter et al. 1993; Gharrett and Smoker 1994; Seeb et al. 1998). Genetic divergence among populations has been interpreted as largely reflecting the patterns of exchange of individuals among populations (gene flow) and random changes in frequency of selectively neutral alleles within populations (genetic drift) (Allendorf and Phelps 1981; Waples 1995). This is a useful approach that allows description of the pattern and amount of gene flow among populations.

This approach to describe population structure is based upon the assumption that the pattern and amount of divergence observed is not affected by natural selection or mutation. However, even weak natural selection may have a substantial effect on the pattern of genetic divergence among populations (Allendorf 1983). In addition, different mutation rates at marker loci may also effect the amount of genetic differentiation between populations, in particular if mutation rates at some loci are high (e.g., Jin and Chakraborty 1995). Thus, the high frequency of mutations that we have detected may also have a substantial effect on the amount and pattern of genetic divergence at some loci.

Molecular markers may be affected by natural selection even if the markers themselves are not the target of selection. Loci that are selectively neutral and have no effect on the phenotype are expected to be affected by the action of natural selection at closely linked loci (Slatkin 1995). Apparent heterozygous advantage ("associative overdominance") can result at neutral loci by linkage disequilibrium with nearby loci that are affected by natural selection (Pamilo and Pálsson 1998). Zhivotovsky et al. (1994) have recently questioned the description of genetic population structure of pink salmon and suggested that natural selection may have an important effect on allozyme frequency divergence in pink salmon.

It has been notoriously difficult to detect and measure the effects of natural selection in natural populations (Lewontin 1991). Comparing the distribution of genotypes in a single cohort followed through different life history stages is the most powerful method to detect natural selection (p. 303, Lynch and Walsh, in preparation). The facilities at the ASLC provide an exceptional opportunity to measure lifetime fitness from fertilization to sexual maturity of molecular genetic markers spread throughout the genome identified in previous years of this project.

B. Rationale/Link to Restoration

The recovery objective for pink salmon is healthy and productive populations that exist at prespill levels or levels in unoiled areas. An indication of recovery is when egg mortality in oiled areas match prespill or levels in unoiled areas. A genetic map would be essential for detecting and understanding causes of reduced egg and embryo survival in oiled areas (Bue et al. 1998). The genetic damage caused by exposure to oil may persist longer in populations of pink salmon than in other vertebrates because of the tetraploid nature of the salmonid genome. Salmonid fishes went through a tetraploid event some 25 million years ago that duplicated their entire genome

(Allendorf and Thorgaard 1984). The extra genes in pink salmon may mask the effects of mutational damage caused by recessive deleterious alleles. The effects of these deleterious mutations may be uncovered in subsequent generations.

This research will provide a powerful test of the assumption of the absence of natural selection affecting molecular markers. This assumption is the foundation of interpreting patterns of genetic divergence among populations as reflecting patterns of genetic exchange. Evidence of natural selection affecting the molecular markers would cause a major change in the interpretation of genetic variation in natural populations of pink salmon and other species. This will be true whether the selection is acting on the markers themselves or chromosomal segments linked to the markers. Recent results from molecular studies of the genome suggest that natural selection may play a greater role than previously thought in determining the structure of the genome, including the organization of genes and chromosomes, as well as the patterns and amounts of genetic variation present (Hurst 1999).

C. Location

Gametes for the inheritance studies and linkage map were collected from Prince William Sound in collaboration with the project Oil-Related Embryo Mortalities (Restoration Study \191A). Embryo incubation took place at the Genetics Lab facilities of ADFG. The laboratory analyses were done at the University of Montana and the ADFG genetics lab in Anchorage.

We began in FY 1998 to use the ASLC Research Facilities at Seward for experiments designed to test for natural selection at loci throughout the genome of pink salmon. Sexually mature pink salmon used in the experimental matings in 1998 and 1999 were collected from Likes Creek in Resurrection Bay. The progeny were marked with an adipose fin clip and released into Resurrection Bay. Due to the failure of the fish pass at the ASLC to attract returning adults we have adjusted our plans for recapturing returning adults from the 1999 cohort to include sampling in upper Resurrection Bay.

COMMUNITY INVOLVEMENT

This is a specialized project that will not benefit directly from the knowledge of local/traditional people. We will hire local residents when possible for assistance (e.g., collecting and maintaining fish). We have developed two computer interactive educational games to be incorporated in displays describing our project at the ASLC ("Lost Child" and "Whose Your Father?"). Amy Haddow, ASLC Education Director, is currently developing a display based upon these games. In addition, we have taken opportunities to explain our research in different Alaska high schools. Kathy Knudsen gave a presentation on this project to the freshman biology class at Kenai High School, and Kate Lindner discussed this study with high school students in Kongiganak.

We are attempting to involve the community of Seward in our project and different aspects of the study such as collecting the returning adults. A lottery was conducted during the 2000 field

season as an incentive to recreational fisherman to turn in any marked pink salmon they caught. This resulted in 18 recreational fishermen turning in 22 marked fish. We are also interested in suggestions of other opportunities for informational meetings in the communities of Prince William Sound, and articles in the Trustee Council newsletter.

PROJECT DESIGN

A. Objectives

Our initial primary objective was to construct a detailed genetic linkage map for pink salmon by analyzing the genetic transmission of several hundred DNA polymorphisms. Pink salmon have 26 pairs of chromosomes (2N=52; Allendorf and Thorgaard 1984), and, therefore, should have a total of 27 linkage-groups: 25 autosomes, an X-chromosome, and a Y-chromosome. We planned to map enough variable markers so that a new marker can be assigned with high probability to one of the 27 linkage groups. It was impossible to know how many markers this would require because we did not know the total length of the pink salmon linkage map. The linkage map of the zebrafish (*Danio rerio*) has been estimated to be 2900 centimorgans (cM; Johnson et al. 1996) and that of the medaka (*Oryzias latipes*) to be 2480 cM (Wada et al. 1995). There currently are efforts to include zebrafish among genome projects of model species sponsored by the National Institutes of Health under the Human Genome Project (Roush 1997). Such a massive effort in zebrafish would provide extremely helpful information for understanding the genome of salmonid fishes.

We expected the pink salmon map to be large because of the polyploid ancestry of salmonids and due to the fact it is female based. Young et al. (1998) recently have published a rainbow trout (*Oncorhynchus mykiss*) linkage map based upon recombination rates in males and estimated the total map to be 2628 cM. However, the linkage map in males will be shorter than in females because of the reduced recombination rate in male salmonids (Johnson et al. 1987a). We initially anticipated that it would be necessary to map over 500 markers to ensure that new markers can be assigned to an existing linkage group with high probability (Van der Beek and Van Arendonk 1993). For example, 99% of all loci in the zebrafish were estimated to be located within 20 cM of a marker on the map based upon an earlier report using 414 markers (Postlethwait et al. 1994).

This project originally had the following overall specific objectives:

1. Develop several hundred variable DNA markers in pink salmon and test them for Mendelian inheritance.

2. Construct a linkage map based upon joint segregation patterns of the DNA polymorphisms detected in previous objective.

3. Map putative lesions identified in Restoration Study \191A.

4. Test for Mendelian inheritance of markers throughout the genome in progeny of fish exposed to oil. Regions that show aberrant segregation ratios in progeny of fish exposed to oil and

normal 1:1 ratios in fish not exposed to oil would be candidates for oil-induced lesions.

5. Test for regions of the genome that are associated with traits of adaptive significance (e.g., marine mortality or run-timing).

6. Test if protein markers (allozymes) are under natural selection such that they may not provide accurate information about the genetic structure and amount of gene flow among populations.

We have completed Objectives 1 and 2. We cannot pursue Objective 3 because Restoration Study /191A did not identify any putative lesions for mapping. At present, we do not intend to pursue Objective 4 because Restoration Study \191A is no longer ongoing. However, this type of experiment to detect oil-induced lesions could be pursued in the future at the ASLC. The primary focus in FY 02 will be Objectives 5 and 6; we propose to use the linkage map to test if there are phenotypic effects and adaptive significance of different classes of molecular markers.

B. Methods

OBJECTIVES 1 & 2

Our initial map was constructed using gynogenetic haploid and gynogenetic diploid progeny from an odd-year individual female (95-103). This is the same procedure that has been used to build the zebrafish linkage map (Postlethwait et al. 1994). Stanley (1983) reported that haploid embryos of Atlantic salmon will develop until just prior to the stage of hatching if development of the eggs is activated by sperm in which the DNA has been inactivated by UV-radiation. We have used this technique routinely with fishes of the genus *Oncorhynchus* (Forbes et al. 1994; Spruell et al. 1999). This allows us to follow the segregation and linkage relationships in haploid progeny from females. The use of haploid progeny avoids possible difficulties of dominance with some types of DNA markers because recessive alleles are not obscured by their dominant alternatives in haploids (Lie et al. 1994). Our odd-year map is primarily based on 603 segregating markers in 94 haploid progeny from a single pink salmon female (A95-103) that returned to Armin F. Koernig hatchery in Prince William Sound in August 1995. We have placed a number of so-called "anchor" loci on this map.

In addition we have initiated the construction of a linkage map based on the segregation pattern of 90 haploid individuals in an even-year female (V96-13). Odd- and even-year pink salmon are reproductively isolated due to the fixed two-year life cycle of this species (Aspinwall 1974). Beacham et al. (1988) report substantial allozyme and morphological evidence for differentiation of alternate brood years. In addition, Phillips and Kapuscinski (1988) and Phillips et al. (1999) detected chromosomal rearrangements between odd- and even-year populations that occur in the same geographical area. Furthermore, in a recent experimental study, Gharrett et al. (1999) demonstrated outbreeding depression in crosses between the two year classes. Together, these finding suggest that the alternate brood years are reproductively isolated and genetically distinct. Having linkage data from both odd- and even-year individuals will make it possible to map more markers and will allow us to determine whether linkage relationships are conserved between the reproductively isolated year classes.

Differences in meiosis between male and female salmonids have been found in all species that have been examined (Allendorf and Thorgaard 1984; Johnson et al. 1987a). There generally is greater recombination in females than in males (Johnson et al. 1987a; Allendorf et al. 1994). In addition, only disomic inheritance has been reported in females. However, in males some loci show patterns of segregation that approach those expected with tetrasomic inheritance (Allendorf and Thorgaard 1984). We will have to test for segregation and linkage in males as well as females because of these sex-specific differences.

Construction of a full linkage map is a large task. We developed as many time and labor saving procedures as possible. Our linkage map was constructed by computer assisted analysis (MapMaker, Lander et al. 1987). We have been assisted by Mark Daly of the Whitehead Institute at MIT in using this program. We will compare the recombination rates based upon this map to rates of selected pairs of loci in males using families produced for the 1998 cohort. The reduced recombination rates in salmonid males means that it will be easier to assign new markers to a linkage group using male parents. We will test joint segregation of individual markers from different linkage groups identified in females to determine if some of these separate linkage groups in females are linked in males and are therefore syntenic (on the same chromosome).

A useful genetic map contains genetic markers that are abundant, randomly distributed throughout the genome, highly polymorphic, and readily detectable in many laboratories (Jacob et al. 1995). We began using random amplified polymorphic DNA (RAPD) markers because they fit these criteria and they have been used successfully in constructing linkage maps in zebrafish and medaka (Johnson et al. 1996; Wada et al. 1995). We have switched to two other types of genetic markers that are superior to RAPDs in this work.

PINEs: There are a variety of repetitive DNA elements that are scattered throughout the genome of salmonid fishes. Greene and Seeb (1997) have described a technique that uses the sequences from a SINE (short interspersed nuclear element) and a transposon to detect many DNA polymorphisms. They have called this technique SINE-printing. We have modified this technique using other types of repetitive elements for our mapping study to detect a class of molecular markers that we call PINEs (paired interspersed nuclear elements; Spruell et al. 1999).

Kido et al. (1991) described 3 SINEs in salmonid fishes. They documented the presence of two such elements, *Hpa*I and *Sma*I, in pink salmon. Spruell and Thorgaard (1996) subsequently reported the presence of the 5'-end of the third element, *Fok*I, in pink salmon. Goodier and Davidson (1994) confirmed that salmonids also contain the transposon *Tc*1, a member of another class of repetitive elements. Both SINEs and transposons occur in high copy number and are believed to be ubiquitously dispersed throughout the genome, making them ideal candidates for genomic mapping efforts.

We have used DNA sequences from four types of repetitive elements as polymerase chain reaction (PCR) primers to generate multiple DNA fragments from a single PCR reaction in pink salmon. The theoretical basis for this procedure is similar to the use of the human SINE *Alu*I to identify human chromosomes in somatic cell hybridization experiments (Nelson et al. 1989).

Primers complementary to one end of the element are oriented such that they initiate DNA synthesis from the end of the element, progressing into the surrounding genomic DNA. A single primer or combinations of primers may be used to generate multilocus patterns. Greene and Seeb (1997) used this technique to confirm the parentage of pink salmon fry, demonstrating the potential utility of including these fragments in our mapping study. We have used 12 different pairs of PINE primers to detect 162 segregating markers in our reference family.

AFLPs: Amplification fragment length polymorphisms have been used extensively in the construction of genomic maps in plants (Maheswaran et al. 1997; Becker et al. 1995). The AFLP technique is especially advantageous for two reasons. First, many bands are produced per reaction and, therefore, more polymorphic loci are produced per unit effort. Second, the selective amplification step uses a subsample of the PCR products of the preamplification. Up to 133 selective amplifications can be completed from a single pre-amplification that originally used only 0.5 μg of genomic DNA. Much less genomic DNA is needed to produce more bands than using other methods such as RAPDs. This is an important consideration when dealing with the limited amount of tissue available from haploid embryos.

Gene-Centromere Map

We estimated recombination rates between 312 loci and their centromeres using half-tetrad analysis in a recently published manuscript (Lindner et al. 2000). We produced the half-tetrads by initiating development with irradiated sperm and blocking the maternal second meiotic division. AFLPs were significantly more centromeric than loci identified by three other techniques (allozymes, microsatellites, and PINEs). The near absence of AFLPs in distal regions could limit their utility in constructing linkage maps. A large proportion of loci had y values approaching 1.0, indicating near complete crossover interference on many chromosome arms. As predicted from models of chromosomal evolution in salmonids, all duplicated microsatellite loci that shared alleles (isoloci) had y values of nearly 1.0. This is consistent with previous data from allozyme loci.

Odd-Year Linkage Map

We have described the segregation of 590 markers in haploid progeny from female A95-103; we have also mapped 13 allozyme loci in the same female (Table 1, Figure 1). We assigned 546 of the 590 markers to one of 44 linkage groups covering a distance of 4559 cM (Table 2). Given the haploid number of 26 chromosomes for pink salmon, our mapping efforts produced 18 extra linkage groups. Taking into account the extra linkage groups and 43 unassigned markers as well as the distance to the telomeres we estimate the size of the pink salmon genome to be 6691 cM. The haploid pink salmon genome is approximately 2.72 million kilobase pairs (kpb; Johnson et al 1987b); thus, we estimate approximately 406 kbp/cM. These results are consistent with our expectations when comparing to maps constructed in other fishes (Table 3).

Table 1. Summary of Marker Types on the Odd-Year Pink Salmon Map

	Number of polymorphic loci	Number of markers unlinked	Percent assigned to linkage group
AFLPs	393	36	91
PINEs	162	7	96
Microsatellites	35	0	100
Allozymes	13	0	100
Total	603	43	93

Table 2. Summary of Odd-Year Pink Salmon Linkage Groups

Number of Markers	Number of groups	Average size (cM)
1-5	10	23.26
6-10	14	53.51
11-15	9	118.50
16-20	6	181.27
21-25	1	189.20
26-30	1	243.70
31-35	2	263.05
36-40	0	--------
41-45	0	--------
46-50	0	--------
over 50	1	457.40

[FIGURE 1 in WORD files (fig-1a.doc; fig-1b.doc; fig-1c.doc)]

[TABLE 3 in WORD file (table-3.doc)]

Putting "Anchor Loci" on the Map

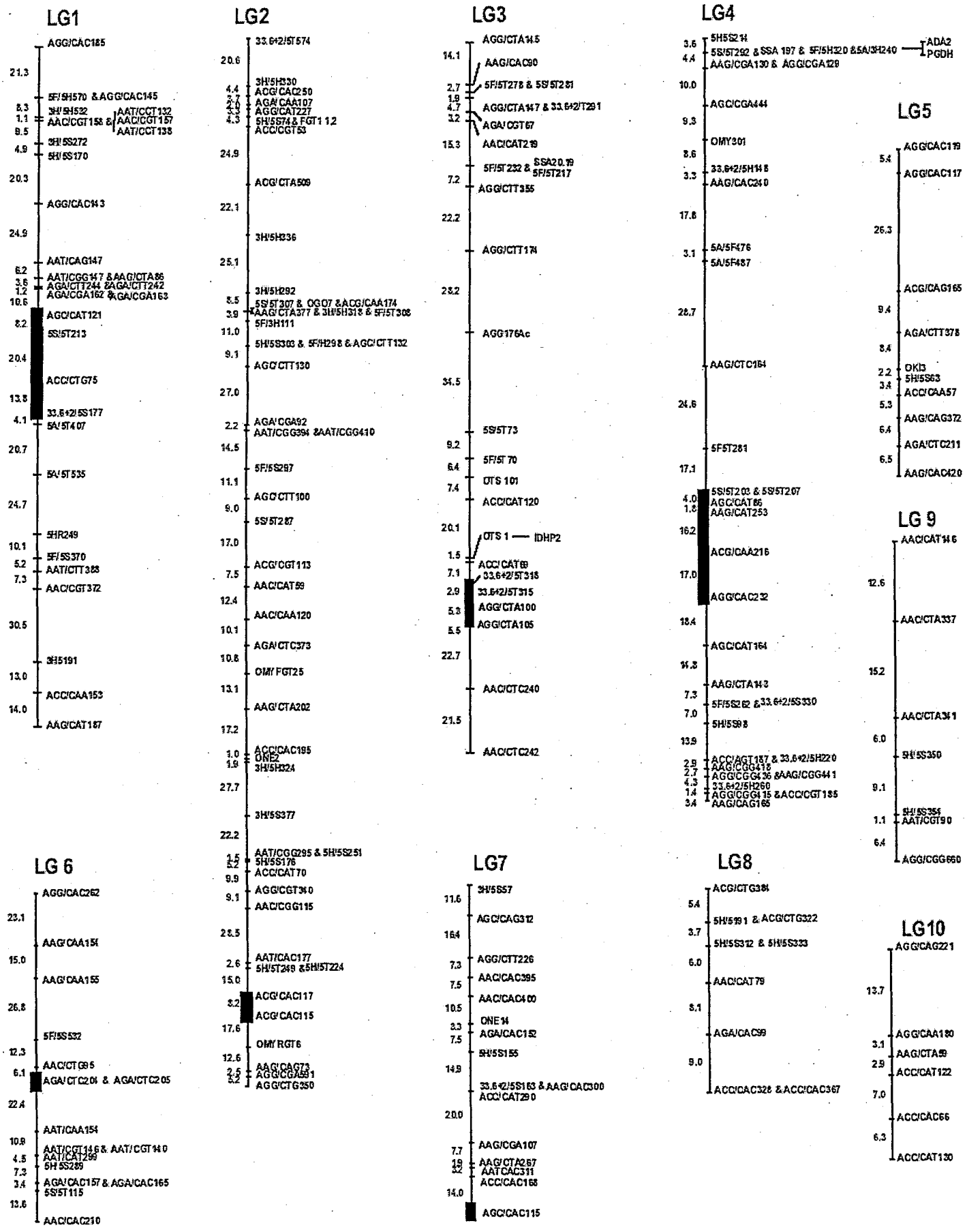
We are still in the process of placing additional loci on the map to aid in consolidation and to make the map useful to other genetic investigators working with salmonids. In particular, it is important to include common markers that can serve as references between maps from divergent taxa (O'Brien et al. 1993). The primary types of so-called "anchor loci" we have used are allozymes and microsatellites that are currently being used in salmonid population genetic studies, including investigations of pink salmon. We will also map other loci that are available and of special interest and usefulness (e.g., growth hormone loci, Forbes et al. 1994, and the major histocompatibility complex, Katagiri et al. 1996; Shum et al. 1996; Miller and Withler 1998). These anchor loci will be used to test for differences in the linkage map between odd- and even-year pink salmon. In addition, we will test for differences in recombination rates, crossover interference, and residual tetrasomic inheritance between males and females (Allendorf and Danzmann 1997).

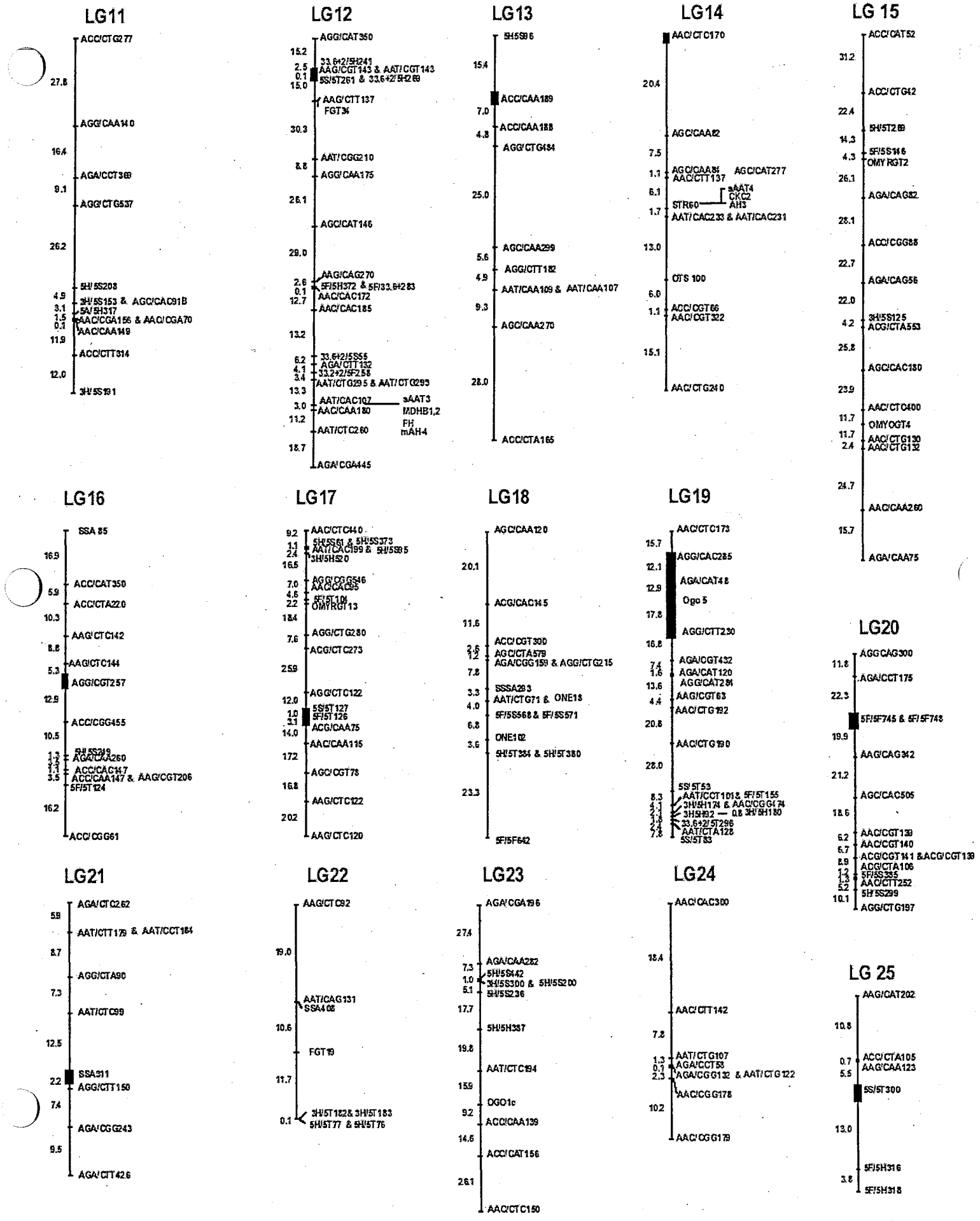
We have placed 35 microsatellite loci on the odd-year map in collaboration with Drs. Roy Danzmann, Moira Ferguson, and Takashi Sakamoto at the University of Guelph in Ontario. These microsatellite loci are found in 17 linkage groups. We have also placed 13 allozyme loci that are polymorphic in Prince William Sound pink salmon (Seeb et al. 1996; Habicht et al. 1998) on the map using gynogenetic-diploids from female A95-103 and several normal diploid families (Table 4) in collaboration with the ADFG Genetics Lab.

Table 3. Comparison of linkage maps from six teleost fishes. Total number of markers included on the map are provided. Sex refers to which gender the map is based on, F= female and M= male. The estimated size takes into account unlinked markers, distance to the telomere, and extra linkage groups. LOD (log odds) is one mapping function used to determine linkage between markers.

	Pink Salmon	Rainbow Trout		Zebrafish	Tilapia		Medaka		Xiphophorus
		Sakamoto et al. 2000	Young et al. 1998	Shimoda et al. 1999	Johnson et al. 1996	Kocher et al. 1998	Naruse et al. 2000	Wada et al. 1995	Morizot et al. 1991
Number of Markers	603	221	476	2000	652	174	634	170	76
Number of Linkage Groups	44	29	42	25	29	30	24	28	17
Number of Chromosomes	26	30	30	25	25	22	24	24	24
Sex	F	M & F	M	M & F	F	F	M & F	M	M & F
Estimated size (cM)	6691	1951	2627	2295	2720	1000-1200	1443	2480	1400-2600
kbp/cM	395	1263	913	740	625	833-1000	554	323	300
LOD	4	3	3	4	3	3	3.5	3	3

Figure 1. Genetic linkage map of odd-year pink salmon based on the inheritance of 603 polymorphic loci. Numbers to the left indicate recombination rates (cM). Locus names are to the right. Centromeres are indicated by black rectangles.




LG11
ACC/CTG277
27.8
AGG/CAA140
16.4
AGA/CCT369
9.1
AGG/CTG537
26.2
5H/5S208
4.9
3H/5S153 & AGC/CAC91B
3.1
5A/5H317
1.5
AAC/CGA156 & AAC/CGA70
0.3
AAC/CAA149
11.9
ACC/CTT814
12.0
3H/5S191
LG12
AGG/CAT350
15.2
33.6+2/5H241
2.5
AAG/CGT143 & AAT/CGT143
0.1
5S/5T251 & 33.6+2/5H269
15.0
AAG/CTT137
FGT36
30.3
AAT/CGG210
8.8
AGG/CAA175
26.1
AGC/CAT146
29.0
AAG/CAG270
2.6
5F/5H372 & 5F/33.6+283
0.1
AAC/CAC172
12.7
AAC/CAC185
13.2
33.6+2/5S55
6.2
AGA/CTT132
4.1
33.2+2/5F258
3.4
AAT/CTG295 & AAT/CTG293
13.3
AAT/CAC107
sAAT3
3.0
AAC/CAA180
MDHB1,2
FH
11.2
AAT/CTC260
mAH4
18.7
AGA/CGA445
LG13
5H/5S96
15.4
ACC/CAA189
7.0
ACC/CAA188
4.8
AGG/CTG484
25.0
AGC/CAA299
5.6
AGG/CTT182
4.9
AAT/CAA109 & AAT/CAA107
9.3
AGC/CAA270
28.0
ACC/CTA165
LG14
AAC/CTC170
20.4
AGC/CAA82
7.5
AGC/CAA86
AGC/CAT277
1.1
AAC/CTT137
6.1
sAAT4
CKC2
STR60
AH3
1.7
AAT/CAC233 & AAT/CAC231
13.0
CITS 100
6.0
ACC/CGT66
1.1
AAC/CGT322
15.1
AAC/CTG240
LG 15
ACC/CAT52
31.2
ACC/CTG42
22.4
5H/5T269
14.3
5F/5S316
4.3
OMYRGT2
26.3
AGA/CAG82
28.1
ACC/CGG85
22.7
AGA/CAG56
22.0
3H/5S125
4.2
ACG/CTA563
25.8
AGC/CAC180
23.9
AAC/CTC400
11.7
OMYOGT4
11.7
AAC/CTG130
2.4
AAC/CTG132
24.7
AAC/CAA260
15.7
AGA/CAA75
LG16
SSA 85
16.9
ACC/CAT350
5.9
ACC/CTA220
10.3
AAG/CTC142
8.8
AAG/CTC144
5.3
AGG/CGT257
12.9
ACC/CGG455
10.5
5H/5S249
1.3
AGA/CAA260
1.3
ACC/CAC147
1.1
ACC/CAA147 & AAG/CGT206
3.5
5F/5T124
16.2
ACC/CGG61
LG17
AAC/CTC440
9.2
5H/5S61 & 5H/5S373
1.1
AAT/CAC199 & 5H/5S95
2.4
3H/5H520
16.5
AGG/CGG546
7.0
AAC/CAC95
4.6
5F/5T106
2.2
OMYRGT13
18.4
AGG/CTG280
7.6
ACG/CTC273
25.9
AGG/CTC122
12.0
5S/5T127
1.0
5F/5T126
3.1
ACG/CAA75
14.0
AAC/CAA115
17.2
AGC/CGT78
16.8
AAG/CTC122
20.2
AAG/CTC120
LG18
AGC/CAA120
20.1
ACG/CAC145
11.6
ACC/CGT300
2.6
AGC/CTA579
1.2
AGA/CGG159 & AGG/CTG215
7.8
SSSA283
3.3
AAT/CTG71 & ONE18
4.0
5F/5S568 & 5F/5S571
6.8
ONE102
3.6
5H/5T334 & 5H/5T380
23.3
5F/5F642
LG19
AAC/CTC173
15.7
AGG/CAC285
12.1
AGA/CAT48
12.9
Ogo 5
17.8
AGG/CTT230
16.8
AGA/CGT432
7.4
AGA/CAT120
1.6
AGG/CAT281
13.6
AAG/CGT63
4.4
AAC/CTG192
20.8
AAC/CTG190
28.0
5S/5T53
8.3
AAT/CCT101 & 5F/5T155
4.1
3H/5H174 & AAC/CGG474
2.1
3H/5H92 — 0.8 3H/5H180
1.6
33.6+2/5T296
3.6
AAT/CTA128
5.2
5S/5T83
7.8
LG20
AGG/CAG300
11.8
AGA/CCT175
22.3
5F/5F745 & 5F/5F748
19.9
AAG/CAG342
21.2
AGC/CAC505
18.6
AAC/CGT139
6.2
AAC/CGT140
6.7
ACG/CGT141 &ACG/CGT139
8.9
ACG/CTA106
1.4
5F/5S355
1.3
AAC/CTT252
5.2
5H/5S299
10.1
AGG/CTG197
LG21
AGA/CTC262
5.9
AAT/CTT179 & AAT/CCT184
8.7
AGG/CTA90
7.3
AAT/CTC99
12.5
SSA311
2.2
AGG/CTT150
7.4
AGA/CGG243
9.5
AGA/CTT426
LG22
AAG/CTC92
19.0
AAT/CAG131
SSA408
10.6
FGT19
11.7
3H/5T182& 3H/5T183
0.1
5H/5T77 & 5H/5T76
LG23
AGA/CGA196
27.4
AGA/CAA282
7.3
5H/5S442
1.0
3H/5S300 & 5H/5S200
5.1
5H/5S236
17.7
5H/5H387
19.8
AAT/CTC194
15.9
OGO1c
9.2
ACC/CAA139
14.6
ACC/CAT156
26.1
AAC/CTC150
LG24
AAC/CAC300
18.4
AAC/CTT142
7.8
AAT/CTG107
1.3
AGA/CCT53
0.1
AGA/CGG132 & AAT/CTG122
2.3
AAC/CGG178
10.2
AAC/CGG179
LG 25
AAG/CAT202
10.8
ACC/CTA105
0.7
AAG/CAA123
5.5
5S/5T300
13.0
5F/5H316
3.8
5F/5H318

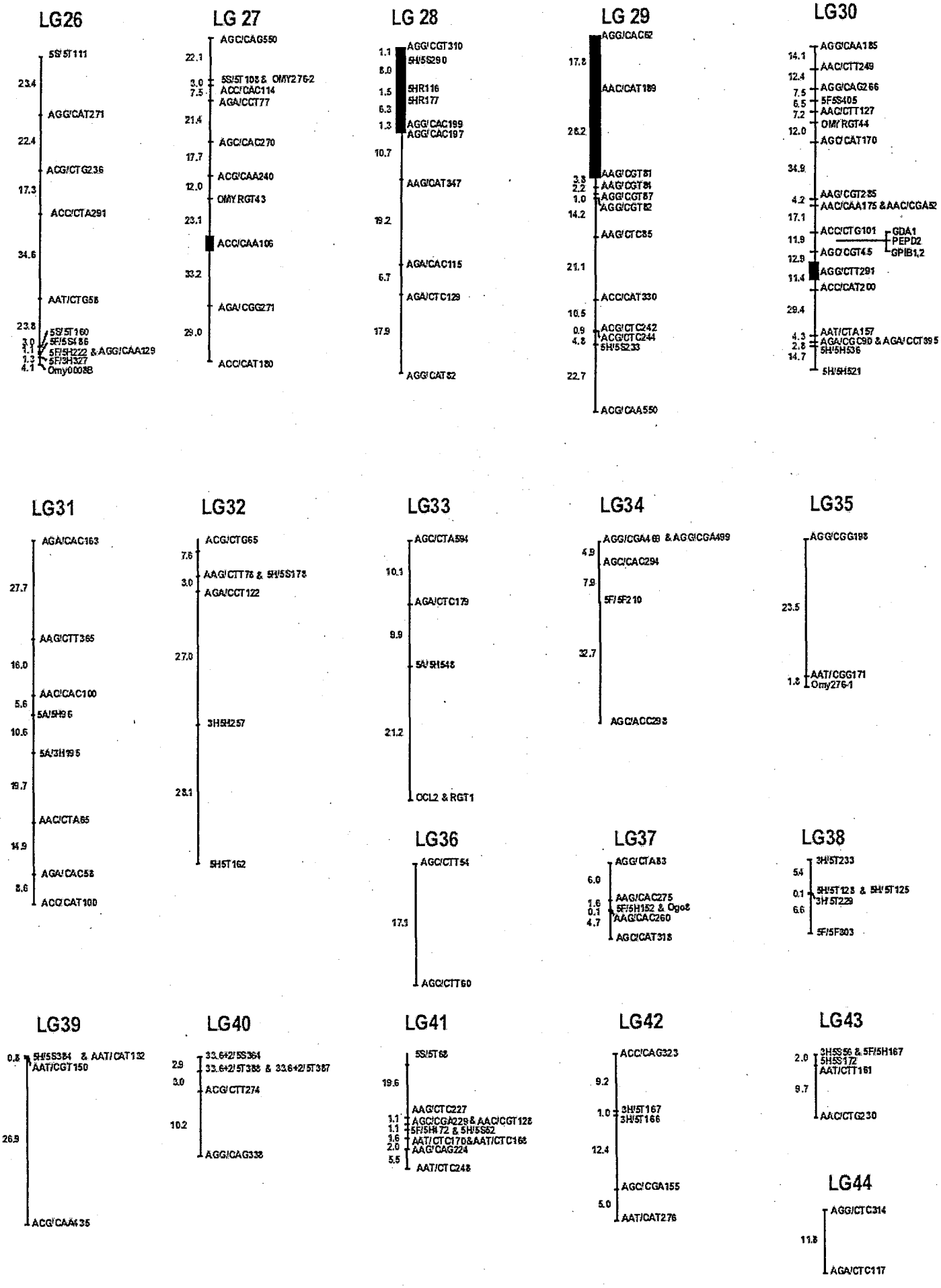
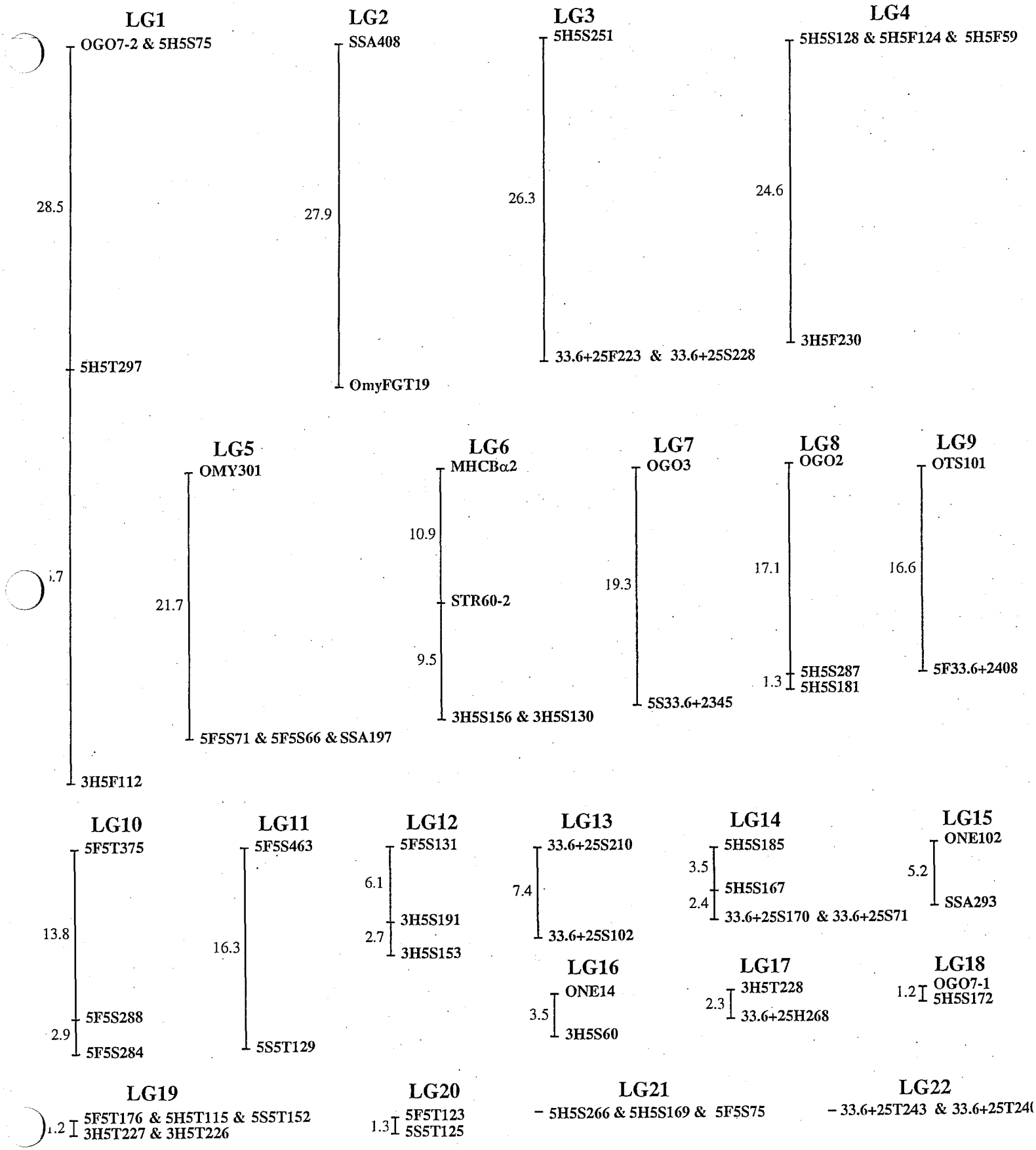

LG26
5S/5T111
23.4
AGG/CAT271
22.4
ACG/CTG236
17.3
ACC/CTA291
34.6
AAT/CTG58
23.8
5S/5T160
3.0
5F/5S186
3.0
1.1
5F/5H222 & AGG/CAA129
1.3
5F/5H327
4.1
Omy0008B
LG 27
AGC/CAG550
22.1
5S/5T108 & OMY276-2
3.0
7.5
ACC/CAC114
AGA/CCT77
21.4
AGC/CAC270
17.7
ACG/CAA240
12.0
OMY RGT43
23.1
ACC/CAA106
33.2
AGA/CGG271
29.0
ACC/CAT180
LG 28
1.1
AGG/CGT310
5H/5S290
8.0
1.5
5HR116
5HR177
6.3
1.3
AGG/CAC199
AGG/CAC197
10.7
AAG/CAT347
19.2
AGA/CAC115
6.7
AGA/CTC129
17.9
AGG/CAT52
LG 29
AGG/CAC62
17.8
AAC/CAT189
26.2
3.8
AAG/CGT81
2.2
AAG/CGT84
1.0
AGG/CGT87
AGG/CGT82
14.2
AAG/CTC85
21.1
ACC/CAT330
10.5
0.9
ACG/CTC242
4.8
ACG/CTC244
5H/5S233
22.7
ACG/CAA550
LG30
AGG/CAA185
14.1
AAC/CTT249
12.4
AGG/CAG266
7.5
5F/5S405
6.5
7.2
AAC/CTT127
OMY RGT44
12.0
AGG/CAT170
34.9
4.2
AAG/CGT285
AAC/CAA175 & AAC/CGA52
17.1
ACC/CTG101
GDA1
11.9
PEPD2
GPIB1,2
AGG/CGT45
12.9
AGG/CTT291
11.4
ACC/CAT200
29.4
4.3
AAT/CTA157
2.8
AGA/CGC90 & AGA/CCT395
5H/5H536
14.7
5H/5H521
LG31
AGA/CAC163
27.7
AAG/CTT365
16.0
AAC/CAC100
5.6
5A/5H96
10.6
5A/3H195
19.7
AAC/CTA65
14.9
AGA/CAC58
8.6
ACG/CAT100
LG32
ACG/CTG65
7.6
AAG/CTT76 & 5H/5S178
3.0
AGA/CCT122
27.0
3H/5H257
28.1
5H/5T162
LG33
AGC/CTA594
10.1
AGA/CTC179
9.9
5A/5H548
21.2
OCL2 & RGT1
LG34
AGG/CGA468 & AGG/CGA499
4.9
AGC/CAC294
7.9
5F/5F210
32.7
AGC/ACC293
LG35
AGG/CGG198
23.5
AAT/CGG171
1.8
Omy276-1
LG36
AGC/CTT54
17.3
AGC/CTT60
LG37
AGG/CTA83
6.0
AAG/CAC275
1.6
5F/5H152 & Ogo8
0.1
AAG/CAC260
4.7
AGC/CAT318
LG38
3H/5T233
5.4
5H/5T125 & 5H/5T125
0.1
3H/5T229
6.6
5F/5F803
LG39
0.8
5H/5S384 & AAT/CAT132
AAT/CGT150
26.9
ACG/CAA435
LG40
33.6+2/5S364
2.9
33.6+2/5T388 & 33.6+2/5T387
3.0
ACG/CTT274
19.2
AGG/CAG338
LG41
5S/5T68
19.6
AAG/CTC227
1.1
AGC/CGA229 & AAC/CGT128
1.1
5H/5H172 & 5H/5S62
3.6
AAT/CTC170 & AAT/CTC166
2.0
AAG/CAG224
5.5
AAT/CTC248
LG42
ACC/CAG323
9.2
1.0
3H/5T167
3H/5T166
12.4
AGC/CGA155
5.0
AAT/CAT276
LG43
2.0
3H/5S56 & 5F/5H167
5H/5S172
AAT/CTT161
9.7
AAC/CTG230
LG44
AGG/CTC314
11.8
AGA/CTC117

Table 4. Summary of linkages in normal diploid families between allozymes and microsatellites. The sex of the informative parent is given in the third column (F = female, M = male). Rate of recombination between loci is indicated by r.

Loci	Family	Informative Parent	N	r	Chi-sq (1 df)
sAAT3 - FH	A95-14	F	86	0.337	9.12
sAAT3 - sMDHB1,2	A95-14	F	89	0.112	53.49
sAAT4 - STR60	A95-104	F	21	0.238	5.76
ADA2 - PGDH	A95-120	M	56	0.125	31.50
ADA2 - SSA197	A95-103	F	42	0.024	38.10
	A95-120	M	18	0.111	10.89
CKC2 - STR60	A95-103	F	46	0.348	4.26
FH - MDHB1,2	A95-14	F	86	0.291	15.07
bGALA - G3PDH1	V96-2	M	75	0.346	7.05
GDA1 - PEPD2	A95-8	M	82	0.012	78.05
	A95-20	M	95	0.105	59.21
	A95-29	M	45	0.000	45.00
G3PDH1 - PEPLT	V96-5	M	75	0.240	20.28
GPIB1,2 - PEPD2	V96-2	M	75	0.013	71.05
sIDHP2 - OTS1	A95-29	M	41	0.366	2.95
	A95-104	F	33	0.303	5.12
PGDH - SSA197	A95-120	M	20	0.050	16.20

Figure 2. Genetic linkage map of pink salmon based on the inheritance of 85 polymorphic loci in one even-year family (V96-13). Numbers to the left indicate recombination rates (cM). Locus names are to the right.



Even-Year Linkage Map

We have completed initial construction of a linkage map for even-year pink salmon from Prince William Sound. We have analyzed the segregation pattern of 85 loci in an even-year family (V96-13) and assigned 63 of 85 loci to one of 22 linkage groups (Table 5, Figure 2). One gene of known function, *MHCB$^{\alpha}$2*, is assigned to a linkage group that consists of one microsatellite and two PINE loci (Figure 2).

Preliminary analysis has not found any differences in location of loci on the maps or recombination rates between the odd- and even-year maps. After the addition of more markers to the even year map we plan to complete the comparative analysis of the odd- and even-year maps, and submit a publication.

Table 5. Summary of Marker Types on the Even-Year Pink Salmon Map

	Number of polymorphic loci	Number of markers unlinked	Percent assigned to linkage group
Microsatellites	19	6	68
PINEs	65	17	74
MHCB α 2	1	0	100
Total	85	23	73

[FIGURE 2 in WORD file (fig-2)]

OBJECTIVES 5 & 6

The completion of a genome map for pink salmon provides important information for addressing genetic issues related to two other Components of the Pink Salmon Restoration Program. The numerous genetic markers identified in the course of this study will provide greatly increased power and resolution to identify stocks of pink salmon on a very fine scale (Stock Separation and Management). In addition, understanding the process of mutation will help identify appropriate markers for use in stock identification. The genome map also provides a platform to test for the presence of genes having major effects on traits of importance for the management of pink salmon, and to test for phenotypes associated with specific combinations of multilocus genotypes (Lander and Schork 1994). These genetic markers will be of great value in genetically identifying fish from supplementation programs (hatchery-raised stocks) and detecting their ecological and genetic interactions with wild fish (Supplementation).

This aspect of the research is being performed at the ASLC research facilities. Approximately 50,000 and 24,000 marked fish were released in spring of 1999 and 2000 respectively. We will collect surviving individuals when they return to upper Resurrection Bay at sexual maturity. A sample of the fish were collected at release and will be analyzed so that their genetic characteristics prior to the marine phase of the life cycle can be compared to the returning adults. We will test for genetic effects on phenotypes of special importance by comparing the genotypes of the released fish with the genotypes of the returning fish. This will allow us to test for genes with a major effect on marine survival. We will test for loci or regions of the genome that have a large effect on phenotypes of interest, so-called quantitative trait loci (QTL's). For example, Jackson et al. (1998) recently have presented evidence for QTL's that affect upper temperature tolerance in rainbow trout linked to two of 24 polymorphic loci that they examined. Mousseau et al. (1998) have used a similar approach to estimate heritabilities for weight, length, and age at sexual maturation in chinook salmon.

Previous work has demonstrated genetic differences in run-timing has a genetic basis (McGregor et al. 1998; Smoker et al. manuscript). We will compare the genotypes of fish returning to the facility at different times to test for genes with a major effect on run timing. We will use a suite of genetic markers spread uniformly throughout the genome. Regions of the genome that show major associations with run-timing can then be examined in more detail by comparing additional markers within that region. A similar approach using only 10 protein markers in hatchery rainbow trout revealed several regions of the genome associated with time of spawning (Leary et al. 1989). Sakamoto et al. (1999) have reported similar results on the basis of 54 microsatellite loci.

Karl and Avise (1992) reported concordant patterns of genetic differentiation for mitochondrial DNA and four nuclear DNA loci in the American oyster (*Crassostrea virginica*) along the east coast of North America. In contrast, previous allozyme studies had not detected these genetic differences among these same populations. Karl and Avise concluded that the pattern observed for the DNA markers reflected the historical patterns of isolation and gene flow among these populations while this pattern is obscured in the allozymes because of "balancing selection" at the allozyme loci. Similar results have been reported in the Atlantic cod (Pogson et al. 1995). These results provide an important challenge to the generally accepted utility of allozyme markers for describing historical patterns and amounts of gene flow between populations. That is, if allozymes are under strong natural selection then they may not provide accurate information about the genetic structure and amount of gene flow among populations.

Restoration Projects 95320D and 96196 have described the genetic population structure in Prince William Sound (PWS) odd- and even-year fish at allozyme loci and mitochondrial DNA (mtDNA) (Seeb et al 1996; Habicht et al. 1998). These studies reported small but statistically significant genetic allele frequency differences among streams, and concluded that pink salmon in PWS should be managed taking into account subpopulation structure rather than as a single panmictic population. As is usually done in such studies, these authors assumed that the genes they examined were selectively neutral (that is, not affected by natural selection). However, the estimates of these authors could be severe overestimates of the actual amount of gene flow if "balancing" selection is maintaining similar frequencies (Karl and Avise 1992; Pogson et al.

1995). That is, there may be much less gene flow among populations than is suggested by these studies.

Zhivotovsky et al. (1994) have reviewed population genetic data of pink salmon and concluded that the interpretations concerning amounts and patterns of gene flow are questionable because even weak natural selection could have a major effect on genetic divergence among populations of pink salmon. A series of papers by Altukhov and his colleagues has provided evidence for phenotypic and fitness effects of genetic variation at allozyme loci in pink salmon (Altukhov 1990; Altukhov et al. 1987, 1989; Dubrova et al. 1995; Kartavtsev 1992). These papers argue that genotypes at allozyme loci have a significant effect on marine survival, growth rate, and several other important factors.

The clearest and perhaps most important effects have been demonstrated on marine survival and growth rates. Pink salmon that are more heterozygous at allozyme loci have greater viability and growth rates than more homozygous individuals (Altukhov et al. 1991; Zhivotovsky et al. 1987; Kartavtsev 1992). Table 6 shows the distribution of individual heterozygosities at four allozyme loci in fry before release into salt water and returning adult spawners in odd-year pink salmon from the Sakhalin Island (Altukhov et al. 1987). We would expect the heterozygosities in fry and adults to be similar if the genotypes at these loci are not associated with survival. The significantly higher heterozygosity in the returning adults (0.619) than in the fry (0.424) indicates that individuals that were more heterozygous at the four loci had greater marine survival.

Altukhov et al. (1991) found a significant positive regression ($r=0.14$; $P<0.01$) between individual heterozygosity at these same four allozyme loci and body length of fry immediately preceding downstream migration from a hatchery on the Sakhalin Island. Kartavtsev (1992) reported a similar relationship in a different experiment with pink salmon from Sakhalin island ($r=0.23$; $P<0.001$). Previous studies with salmonids have found that size has an important effect on survival (Hunt 1969).

Table 6. Distribution of Heterozygosity at Four Allozyme Loci in Pink Salmon from Sakhalin Island

	Number of heterozygous loci*			
Age-class	0	1	2-4	Average Heterozygosity
Fry	0.620 (559)	0.336 (302)	0.044 (40)	0.424 (901)
Adults	0.495 (300)	0.391 (237)	0.144 (69)	0.619 (606)

$\chi^2 = 37.3$
d.f. = 2
$P<0.001$

* values are the frequencies (and number) of individuals with the indicated number of heterozygous loci.

Similar results have been reported in other salmonid species for many phenotypes of evolutionary importance (e.g., developmental rate, egg size, and disease resistance; reviewed by Ferguson 1992). Positive associations between heterozygosity at allozyme loci and important phenotypic characters, such as growth rate, survival, fertility, disease resistance, developmental rate, and developmental stability, have been described in many organisms (reviewed by Zouros and Foltz 1986; Allendorf and Leary 1986).

The mechanism underlying these associations remains unknown. The most likely explanations are (1) the associations are the consequence of heterozygosity at the loci examined, or (2) the loci examined may be in linkage disequilibrium with other loci that affect the traits being studied (associative overdominance; Leary et al. 1987).

It has been argued that these relationships between multiple locus heterozygosity and phenotypes have been found with allozymes because these loci are important in ATP production and protein catabolism (Koehn et al. 1988). We propose to distinguish between these hypotheses by using the linkage map to compare the effects of different markers on marine survival and other traits. If the enzyme loci themselves are responsible for this effect, then we would expect to find an association between enzyme genotypes and survival, but not between genotypes at DNA markers spread throughout the nuclear genome. However, if we find a similar association using DNA markers, this would suggest that the effect is due to chromosomal segments and not the enzyme loci themselves.

We believe that it is unlikely that the enzyme loci themselves are responsible for the observed

relationships. Nevertheless, regardless of the underlying mechanisms of these associations, even weak heterozygous advantage (or associative overdominance) would act to maintain similar allele frequencies in different populations in the absence of significant gene flow (Allendorf 1983). This could cause a large overestimation of the actual amount of gene flow among Prince William Sound pink salmon populations. For example, just a 10% selective advantage of heterozygotes will cause a 10-fold over estimation of the amount of migration in the case where local populations have an effective size of 100 and an average 0.5 migrants per generation (Allendorf 1983). Altukhov et al. (1987) have estimated an average selective advantage of approximately 25% at four allozyme loci in pink salmon.

We will ask a series of questions in this aspect of the research. The primary question is are there regions of the genome that have a significant effect on survival during the marine phase of the life cycle? Secondarily, we will ask if allozyme markers tend to occur in those regions that affect survival. We will also determine if selection favors heterozygotes.

Marine Survival and Fitness Experiment: 1998 cohort

In August 1998, 150 (75 male and 75 female) mature pink salmon were collected from Likes Creek, Resurrection Bay, and transported to the ASLC for controlled matings. We made 75 families of full-sibs by crossing one male and one female. One hundred progeny from each family were collected to test marker inheritance for parentage analysis. We then selected 50 of these families on the basis of egg number and survival during incubation for the release experiment. These families were pooled together into a single tank in March shortly after hatching. In May 1999, approximately 1,500 progeny from each of these 50 single-pair mating families were marked and released from the ASLC facility.

Progeny from this experiment returned in August 2000. We had anticipated a return rate of 2%, for a total of 1,000-2,000 individuals expected to be recovered for genetic and morphological analyses (approximately 30 fish per family). However, no fish returned to the ASLC fish pass. We did capture a total of 36 fish from 30 families throughout Resurrection Bay (Table 7, Figure 3). Based on the number of fish collected with our limited resources it is clear that a large number of marked fish did survive and returned to Resurrection Bay. We were not able to achieve any of our objectives with this small number of fish. It is interesting to note, however, that fish from the same family did tend to return at the same time, indicating a genetic component to time of return (Table 7).

[TABLE 7 in WORD file (table-7.doc)]

[FIGURE 3 in WORD file (fig-3.doc)]

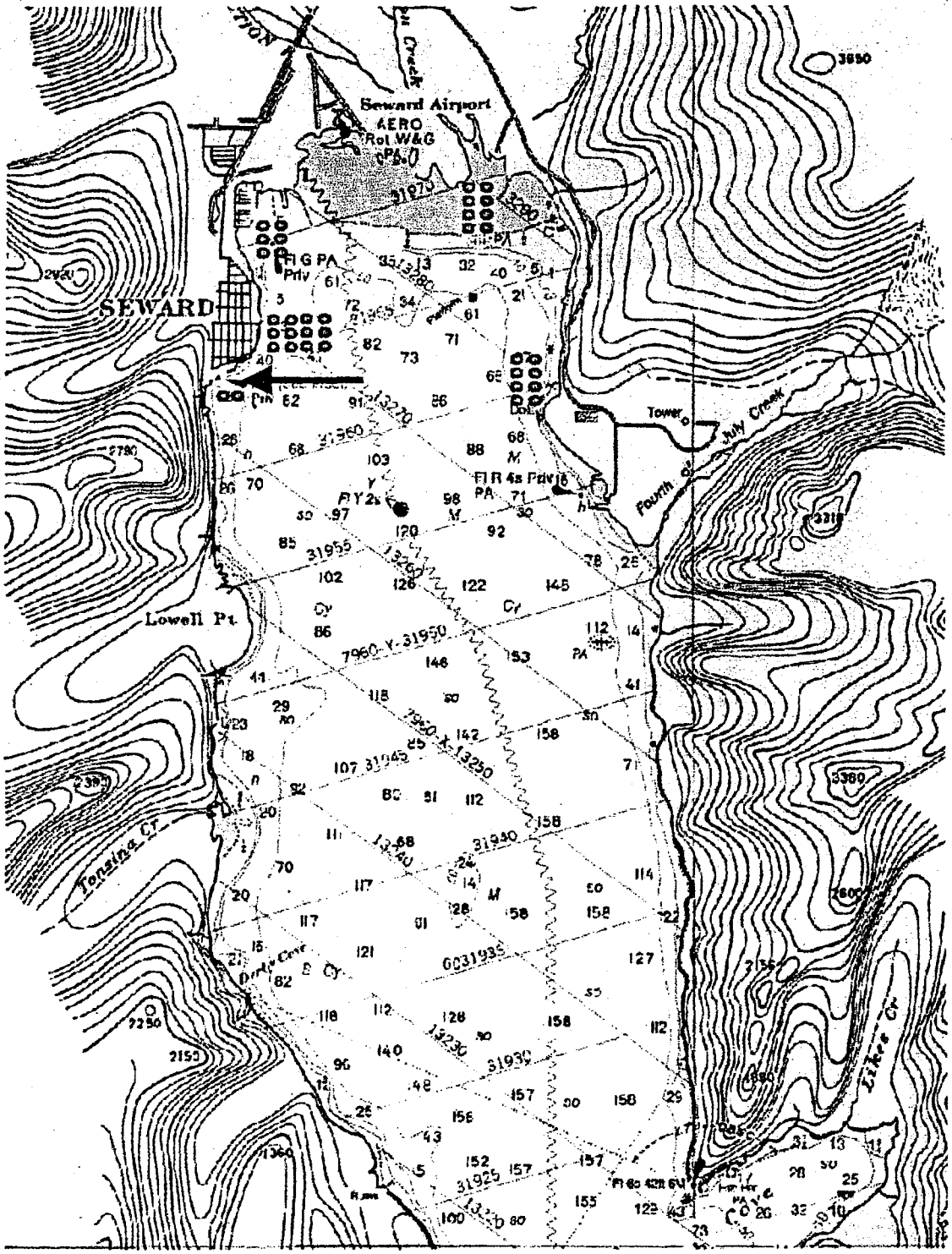
Marine Survival and Fitness Experiment: 1999 cohort

We repeated this experiment with odd-year pink salmon in August 1999. We collected 68 adults (34 females and 34 males) from Likes Creek, and released their marked progeny from the

Table 7. Summary of adult marked pink salmon collected from freshwater streams in upper Resurrection Bay. Sex is abreviated, F = female and M = male. Each individual was assigned back into its family of origin as reported in the last column.

Individual #	Sex	Date Collected	Location	Length (mm)	Family #
1	F	August 7	Culvert	480	73
2	M	August 7	Culvert	490	46
3	M	August 15	Lowell Cr.	478	11
4	M	August 15	Harbor	478	61
5	F	August 16	Lowell Cr.	441	69
6	M	August 16	Spring Cr.	430	6
7	F	August 17	Culvert	444	27
8	M	August 17	Culvert	473	50
9	M	August 17	Culvert	510	72
10	M	August 17	Harbor	496	23
11	F	August 18	Spring Cr.	457	63
12	F	August 18	Culvert	456	74
13	M	August 18	Spring Cr.	467	28
14	M	August 18	Culvert	435	9
15	M	August 21	Spring Cr.	437	73
16	F	August 22	Culvert	446	49
17	F	August 22	Resurrection R.	484	19
18	F	August 22	Spring Cr.	475	25
19	F	August 22	Resurrection R.	457	38
20	M	August 22	Resurrection R.	418	12
21	F	August 23	Resurrection R.	475	19
22	F	August 24	Culvert	458	15
23	F	August 24	Harbor	483	58
24	M	August 24	Harbor	447	7
25	F	August 25	Resurrection R.	466	75
26	F	August 25	Resurrection R.	470	75
27	M	August 25	Spring Cr.	397	53
28	M	August 25	Culvert	478	64
29	M	August 27	Culvert	508	23
30	F	August 28	Harbor	475	49
31	F	August 28	Resurrection R.	519	45
32	M	August 28	Resurrection R.	473	40
33	M	August 29	Harbor	470	41
34	F	August 30	Spring Cr.	499	45
35	F	August 30	Spring Cr.	470	21
36	F	September 2	Culvert	466	51

Figure 3. Nautical map of upper Resurrection Bay. Circles indicate where marked pink salmon determined to be part of our study were collected in August and September 2000. Arrow indicates the location of the Alaska SeaLife Center.



ASLC in May 2000. This cohort should return in the summer of 2001. We used a different experimental mating scheme with these fish to allow a more powerful genetic analysis of the progeny. Each male and each female was crossed with two individuals in a series of 2 x 2 diallele crosses (Figure 4). Based on results from 2000, we do not expect our fish to return to the ASLC. Therefore, we are planning a more extensive survey of freshwater streams in upper Resurrection Bay.

[FIGURE 4 in WORD file (fig-4.doc)]

Mutation Analysis

Our results have provided exciting and important information about mutation processes in microsatellites which we have described in a manuscript for submission to the journal Molecular Biology and Evolution. Our experimental design depends upon being able to place returning adults into their correct family on the basis of their multiple-locus genotypes. We tested this by examining inheritance data at 11 loci (nine microsatellites and two genes of known function) for 10 progeny from each of the 50 families that were released in spring of 1999. In the process of analyzing the inheritance data, we detected several mutations at two of the microsatellite loci (*SSA408* and *OGO1c*), indicating that these loci have particularly high mutation rates. Furthermore, at *SSA408* the mutations detected were not distributed randomly among families. Rather, clusters of identical mutant alleles were found in certain families, suggesting they may have resulted from mutation events occurring very early in gametogenesis, prior to meiosis.

To further evaluate mutation rates and patterns, we genotyped 35-40 progeny from each of five of the 1998 cohort families at the nine microsatellite loci included in the initial inheritance analysis (Table 8). We combined the data for these progeny and the initial inheritance data for estimation of mutation rates. Sixteen of the individuals in this dataset have genotypes best explained as resulting from mutation events (Table 9a). Five of the mutations were at *OGO1c* and 11 were at *SSA408*. Because each individual inherits two copies of each gene, we estimated mutation rates as the number of mutations/two times the number of individuals genotyped. The resulting mutation rate estimates at *SSA408* and *OGO1c* are 8.5×10^{-3} and 3.7×10^{-3} respectively (Table 8). No mutations were detected at any of the other seven loci, indicating that their mutation rates are lower than could be detected with our data.

[TABLE 8 in WORD (table 8.doc)]

[TABLE 9 in WORD (table 9.doc)]

We also analyzed additional progeny from the two families which had several individuals with identical mutations at *SSA408* in the initial inheritance study. Two more mutant individuals were detected in 36 additional progeny sampled from family 98-23 and five were found in 40 additional progeny from family 98-26 (Table 9b). The fact that the same mutant allele at *SSA408* was transmitted to a total of nine of 50 embryos from family 98-26 and similarly to four of 46 embryos in family 98-23 (Table 10) strongly suggests that these are premeiotic cluster mutations. In sexually reproducing animals, gametes develop from primordial germ cells (PGCs) that differentiate from the somatic cells

Figure 4. Diagram of our half-sib family experimental design. Numbers across the top represent females, numbers down the side represent males. The squares represent individuals used to make each family.

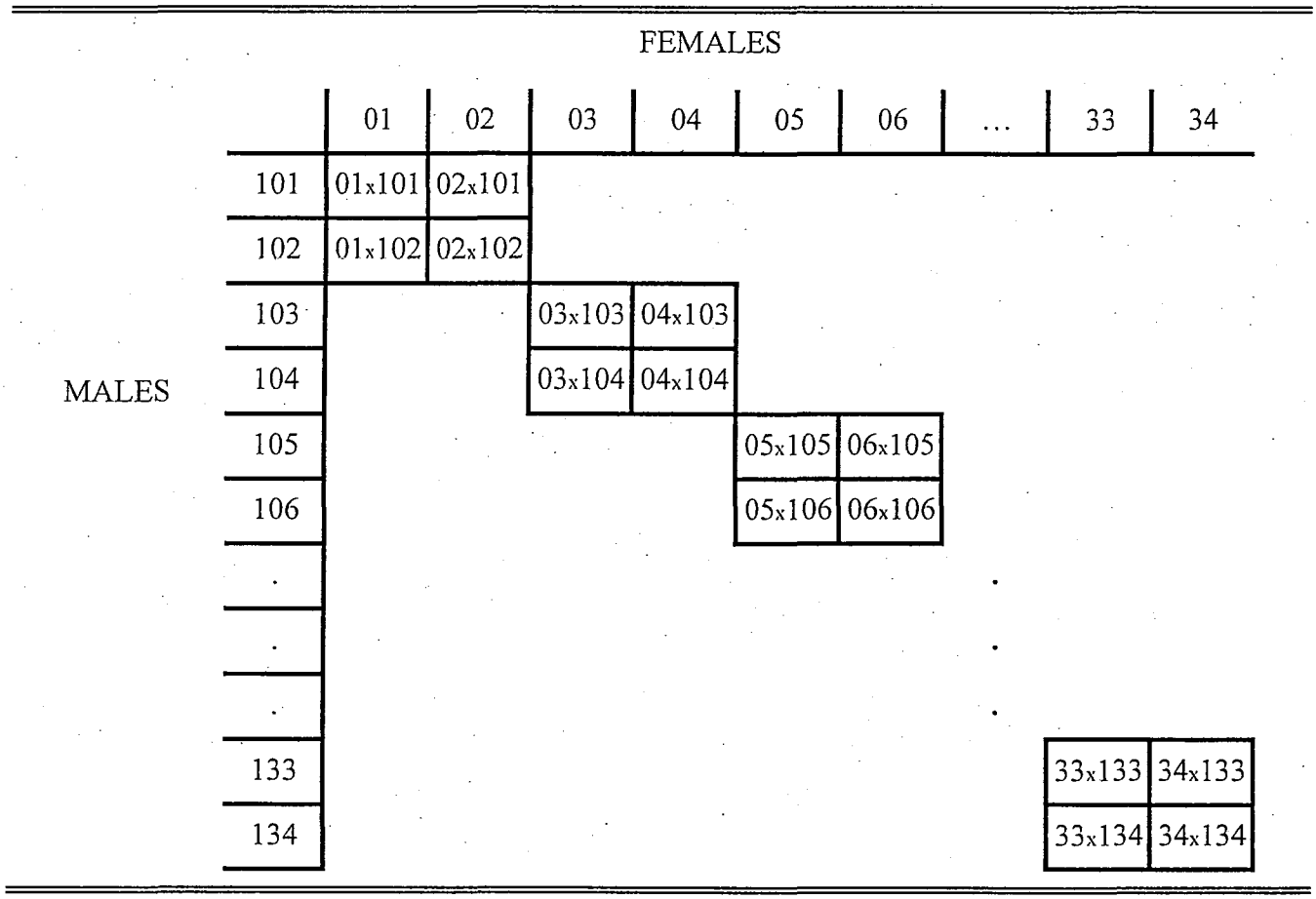


Table 8. Microsatellite loci amplified in 50 full-sib families of pink salmon produced in 1998. Number of alleles and expected heterozygosity (H_e) are based on the parental population. Mutation rate estimates are calculated as the number of mutant alleles detected divided by the total number of alleles analyzed (see text).

Locus	Number of Alleles	H_e	Mutation Rate
OGO1c	77	0.983	3.7×10^{-3}
OGO8	17	0.334	0.0
OMY301	21	0.856	0.0
OMYRGT6	18	0.922	0.0
ONE$_\mu$3	3	0.507	0.0
OTS1	15	0.829	0.0
*SSA20.19-1**	2	0.058	0.0
*SSA20.19-2**	3	0.307	0.0
SSA408	49	0.972	8.5×10^{-3}

* Multiple allelic banding patterns and the sequences of these bands in *O. gorbuscha* (unpublished data) indicates that *SSA20.19* is a duplicated locus.

Table 9. Mutations observed at two microsatellite loci; a) data from the initial inheritance study with additional progeny from five randomly selected families (see text); b) data for families 98-23 and 98-26 (includes results from 9a).

a)

SSA408:			*OGO1c*:		
Family	# Individuals	# Mutants	Family	# Individuals	# Mutants
98-15	46	1	98-44	9	1
98-19	46	1	98-51	10	1
98-22	9	1	98-64	10	1
98-23	10	3	98-71	44	2
98-26	10	4	46 others	566	0
98-34	46	1			
44 others	483	0	TOTAL:	668	5
TOTAL:	650	11			

b)

SSA408:		
Family	# Individuals	# Mutants
98-23	46	5
98-26	50	9
TOTAL:	96	14

very early in development. These cells eventually migrate to the area of the developing gonads where the germ cells are produced. The number of PGCs produced varies widely among organisms (reviewed by Matova and Cooley 2001). In zebrafish (*Danio rerio*), researchers combining morphological and mRNA expression studies using germ line markers have recently determined that by the 5-somite (32-cell) stage and until about the 1000 cell stage there are four PGCs (Braat et al. 1999). During their migration towards the gonads the four PGCs give rise to 20-30 cells that populate the gonad and differentiate into germ cells (Braat et al. 1999). In theory, if there is a mutation in one of the original four PGCs, approximately one out of eight (12.5%) of the progeny should inherit the mutant allele. Assuming gametogenesis is similar in pink salmon, our findings of nine identical mutant alleles out of the 50 transmitted maternally (18%) in family 98-26 and four of 46 identical mutant alleles (8.7%) transmitted paternally in family 98-23 suggest that each of these mutations likely occurred either in one of the four PGCs or in the subsequent one or two generations of cells that populated the gonad.

[TABLE 10 in WORD (table 10.doc)]

The occurrence of clustered mutations results in non-uniform distributions of novel alleles in a population which, if not identified as such, could influence interpretations of mutation rates and patterns as well as interpretations of patterns of genetic population structure. Woodruff et al. (1996) have shown that mutant alleles that are part of clusters are more likely to persist and be fixed in a population than mutant alleles entering the population independently. In the present study, 13 of the 23 mutant alleles detected (57%) apparently resulted from premeiotic mutations. Jones et al. (1999) similarly found that a high proportion (40%) of new mutants observed in pipefish (*Sygnathus typhle*) occurred in mutational clusters. No other published accounts of cluster mutations in fish microsatellites were found, however these results are similar to the estimates from *Drosophila* of 20-50% reported by Woodruff et al. (1996).

Microsatellite mutations are generally thought to result from DNA polymerase strand slippage (Levinson and Gutman 1987, Weber and Wong 1993). Recent evidence indicates there is a tendency towards upward biases in size change (Amos et al. 1996, Primmer et al. 1996, Wierdl et al 1997). To evaluate whether the mutations we detected reflected size increases or decreases, we assumed the progenitor of the mutant allele was the parental allele that was closest in size (Table 10). Assuming single mutation events account for the mutation clusters at *SSA408* in families 98-23 and 98-26, six of the seven mutant alleles detected involved size increases of four bases. At *OGO1c* three of the five mutations detected resulted in size increases of four bases and two resulted in size decreases of four bases. All of these changes are consistent with single repeat unit addition or deletion mutations at both loci with a bias towards increasing the number of repeats at *SSA408*. Banks et al. (1999) similarly found that the single mutation in their study of the inheritance of microsatellites in chinook salmon was a gain of a single repeat-unit.

These results have important significance for the use of microsatellite loci in management. Mutations are expected to have a substantial effect on the amount and pattern of genetic divergence among populations if the mutation rate approaches the rate of migration among populations (see discussion in Allendorf and Seeb 2000). Not surprisingly, the number of mutations detected was correlated with the number of alleles in the sample (Table 8). We detected mutations at the two loci that have the greatest number of alleles in the parental population (*OGO1c* and *SSA408*, Table 8). The mutation rate estimates at *OGO1c* and *SSA408* (3.7×10^{-3} and 5.4×10^{-3}) are at the high end of the range of

Table 10. Mutations observed in 1998 cohort families. Parental genotypes are reported with the most likely progenitor of the mutant allele underlined. Progeny genotypes are summarized with the mutant allele in bold followed by the number observed (n).

Locus	Family	Dam	Sire	Progeny Genotypes							Total
		a/b	*c/d*	*a/c*	*a/d*	*b/c*	*b/d*	genotypes not matching parents (#)			
SSA408	98-15	334/382	322/<u>370</u>	14	9	9	13	***334/374*** (1)			46
	98-19	<u>338</u>/350	378/404	15	12	8	10	***342/404*** (1)			46
	98-22	334/404	<u>350</u>/366	4	1	1	2	***334/354*** (1)			9
	98-23	326/382	<u>366</u>/386	7	17	8	7	***326/370*** (1)	***382/370*** (3)	***326/362***(1)	44
	98-26	<u>316</u>/404	312/450	9	12	12	8	***320/450*** (4)	***320/312*** (5)		50
	98-34	354/386	370/<u>440</u>	12	10	6	17	354/***444*** (1)			46
OGO1c	98-44	342/350	408/<u>474</u>	1	1	3	3	***342/478*** (1)			9
	98-51	295/366	303/<u>362</u>	1	2	4	2	***295/366*** (1)			10
	98-71	269/420	346/<u>450</u>	8	16	10	8	***420/446*** (2)			44
		a/a	*c/d*								
	98-64	348/348	309/<u>448</u>	5	4	0	0	***348/444*** (1)			10

10^{-3} to 10^{-6} reported for other organisms (Dallas 1992, Weber and Wong 1993, Schug et al. 1997). The variability of these two loci makes them powerful tools for assigning parentage. We were able to unambiguously assign parentage to 35 of the 36 returning fish from the 1998 cohort based on these two loci alone. However, given the high probability of mutation at these loci, our results indicate that it is important to use a combination of low and high variability markers for parentage analysis. Our mutation analysis also suggests that *OGO1c* and *SSA408* are inappropriate as markers for analysis of stock structure in pink salmon.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The ADFG Genetics Lab is no longer funded to assist us in the work at the ASLC. Therefore, we are currently doing all of the allozyme analysis at the University of Montana.

SCHEDULE

A. Measurable Project Tasks for FY 02 (1 Oct 01 - 30 Sep 02)

1 Oct 01 - 31 Dec 01: Complete genetic analyses of fry from 1999 cohort sampled at time of release from the ASLC.

1 Oct 01 - 31 Dec 01: Perform morphological analysis of returning adults from 1999 cohort.

1 Oct 01 - 31 July 02: Perform genetic analyses of returning adults from 1999 cohort.

1 Dec 01 - 30 Sep 02: Perform data analysis to test for correlations between markers from the linkage map and traits associated with marine survival and fitness in the returns of the 1999 cohort.

1 Oct 01 - 1 Mar 02: Add markers to the even-year linkage map.

1 Jan 02 - 30 Sep 02: Prepare manuscript for publication describing results of marine survival and fitness experiment.

1 Mar 02 - 30 Sep 02: Prepare manuscript for publication comparing odd- and even-year linkage maps.

B. Project Milestones and Endpoints

Objective 1: This objective has been completed.

Objective 2: This objective has been completed.

Objective 3: This objective will not be pursued.

Objective 4: This objective will not be pursued.

Objective 5: This objective will be completed by the end of year 8.

Objective 6: This objective will be completed by the end of year 8.

C. Completion Date

We initially proposed to continue this work for five years. However, our release experiments were delayed until the ASLC facilities were available. The 1998 cohort fish released in the spring of 1999 returned at the end of year five, and the 1999 cohort fish will return at the end of year six. Genetic analysis should be completed by the end of year seven and data analysis and publications completed by the end of year eight.

PUBLICATIONS AND REPORTS

Allendorf, F. W., P. Spruell, K. L. Knudsen, K. R. Lindner and K. L. Pilgrim. 1997. Construction of a Linkage Map for the Pink Salmon Genome, *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 97190), University of Montana, Missoula, Montana.

Allendorf, F. W., P. Spruell, K. L. Knudsen, K. R. Lindner, D.J. Reedy, and K. L. Pilgrim.1998. Construction of a Linkage Map for the Pink Salmon Genome, *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 98190), University of Montana, Missoula, Montana.

Allendorf, F. W., P. Spruell, K. L. Knudsen, and K. R. Lindner. 1999. Construction of a Linkage Map for the Pink Salmon Genome, *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 99190), University of Montana, Missoula, Montana.

Spruell, P., B.A. Greene, C. Habicht, K.L. Knudsen, K.R. Lindner, J.B. Olsen, K.L. Pilgrim, G.K. Sage, J.E. Seeb, and F.W. Allendorf. 1999. Inheritance of nuclear DNA markers in gynogenetic haploid pink salmon (*Oncorhynchus gorbuscha*). Journal of Heredity 90:289-296.

Lindner, K. R., E. K. Steinberg, P. Spruell, K. L. Knudsen, A. Maxwell, and Allendorf, F. W. 2000. Construction of a Linkage Map for the Pink Salmon Genome, *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 00190), University of Montana, Missoula, Montana.

Lindner, K.R., J. E. Seeb, C. Habicht, K.L. Knudsen, E. Kretschmer, D. J. Reedy, P. Spruell, and F. W. Allendorf. 2000. Gene-centromere mapping of 312 loci in pink salmon by half-tetrad analysis. Genome 43:538-549.

Steinberg, E.K., K.R. Lindner, J. Gallea, J. Meng, A.Maxwell, and F.W. Allendorf. Rates and patterns of microsatellite mutations in pink salmon. To be submitted to Molecular Biology and Evolution.

Lindner, K.R., P. Spruell, C. Habicht, J. E. Seeb, H. Zhao, and F. W. Allendorf. In preparation. Estimation of chiasma interference and construction of a linkage map for pink salmon. To be submitted to Genetics.

PROFESSIONAL CONFERENCES

We anticipate presenting our results at professional and scientific meetings.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This work has been done in collaboration with James E. Seeb, Principal Geneticist, ADFG. The inheritance experiments were performed in coordination with the project Oil-Related Embryo Mortalities (Restoration Study \191A). Dr. Seeb is no longer funded to collaborate with us in this Restoration Study.

This work is related to my ongoing genetic research with salmonid fishes that has been supported by the National Science Foundation since 1980. Many of the techniques and approaches proposed here are based upon the results of that research. I also intend to continue seeking support from NSF that will complement the research proposed here. A genetic map for pink salmon will allow us to address a number of fundamental questions in the conservation and genetics of pink salmon and other *Oncorhynchus* species.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

The changes in this proposal reflect the discontinuation of Restoration Study \191A, and the decision not to fund our ADFG collaborators on this project. We have made changes in our plans to capture fish returning to Resurrection Bay based upon the lack of any returns to the ASLC in summer 2000.

PROPOSED PRINCIPAL INVESTIGATOR

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approved 12-11-01

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel		$0.0
Travel		$0.0
Contractual		$157.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$157.0
General Administration		$11.0
Project Total	$0.0	$168.0
Full-time Equivalents (FTE)		0.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 2003					
$80.3					

Dollar amounts are shown in thousands of dollars.

Comments:

NOTE: This budget was approved by the Trustee Council in two steps. In August 2001, the Council approved $43,100 ($40,300 in direct costs and $2,800 in ADF&G GA) in interim funds. In December 2001, the Council approved the balance of $124,900 ($116,700 in direct costs and $8,200 in ADF&G GA). A copy of the interim budget is on file at the Restoration Office.

FY02

Prepared: 4/01

Project Number: 02190
Project Title: Construction of a Linkage Map for the Pink Salmon Genome
Agency: ADF&G

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Approved TC 10-11-01

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	LONG RANGE FUNDING REQUIREMENTS					
Personnel	$132.0	$93.7						
Travel	$14.1	$1.8						
Contractual	$0.0	$0.0						
Commodities	$35.5	$29.7						
Equipment	$0.0	$0.0						
Subtotal	$181.6	$125.2	Estimated FY 2003					
Indirect	$41.9	$31.8						
Project Total	$223.5	$157.0	$75,000.0					
Full-time Equivalents (FTE)	3.2	1.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Indirect costs are based on the University of Montana rate of 43.7% of salaries and wages.

Travel costs are included to attend the Trustee Council Annual Restoration Workshop.

Travel costs are included to attend one scientific meeting to present results.

Personnel time includes time for annual report and manuscript preparation.

FY02

Project Number: 02190
Project Title: Construction of a Linkage Map for the Pink Salmon Genome
Name: University of Montana

FORM 4A
Non-Trustee
SUMMARY

Prepared: April, 2001

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2002
	F Allendorf	Project Director	1.5	10.7		16.1
	P Spruell	Research Scientist	2.0	4.3		8.6
	K Lindner	Research Specialist	12.0	3.9		46.8
	K Knudsen	Research Specialist	3.0	4.4		13.2
	M Skinner	Research Specialist	3.0	3.0		9.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	21.5	26.3	0.0	
					Personnel Total	$93.7

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2002
						0.0
	Missoula to Anchorage for the Trustee Council Restoration Workshop.	0.7	1	2	0.1	0.9
						0.0
	Travel to a national meeting to present results.	0.6	1	3	0.1	0.9
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$1.8

FY02

Project Number: 02190
Project Title: Construction of a Linkage Map for the Pink Salmon Genome
Name: University of Montana

FORM 4B
Personnel
& Travel
DETAIL

Prepared: April, 2001

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:	Proposed FY 2002
Description	
Contractual Total	$0.0

Commodities Costs:	Proposed FY 2002
Description	
Materials and supplies for microsatellite, allozyme, and morphological analysis.	16.0
FMBIO fluorescent scanner service and maintenance contract	7.7
Equipment repair and maintenance	5.5
Communications	0.5
Commodities Total	$29.7

FY02

Project Number: 02190
Project Title: Construction of a Linkage Map for the Pink Salmon Genome
Name: University of Montana

FORM 4B
Contractual & Commodities DETAIL

Prepared: April, 2001

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2002
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units
Hitachi FMBIO 100 Fluorescent Imaging Scanner	1

FY02

Project Number: 02190
Project Title: Construction of a Linkage Map for the Pink Salmon Genome
Name: University of Montana

FORM 4B
Equipment
DETAIL

Prepared: April, 2001

approved TC 12/11/0

Sound Ecosystem Assessment (SEA): Printing the Final Report

Project Number:	02320
Restoration Category:	Research
Proposer:	William J. Hauser Alaska Department of Fish and Game
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	
Alaska SeaLife Center:	no
Duration:	October 1, 2001 to September 30, 2002. First year of a one-year project.
Cost FY 00:	$2,100
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pink salmon and Pacific herring

ABSTRACT:

This proposal will provide funding to print, bind and distribute the Final Report package from the EVOS TC Sound Ecosystem Assessment (SEA) project. The integrated final report is a required document expected to exceed 1000 pages (some with color). This product represents the closeout documentation for SEA specified in the FY99 single integrated DPD. Funding for copying, binding and mailing the Final Report was provided in FY2000, but completion has been delayed and the encumbered funds cannot be spent after 30 June 2001. The FY2000 unused encumbered funds will be allowed to lapse.

INTRODUCTION

The Sound Ecosystem Assessment (SEA) program was initiated in April 1994 to evaluate possible environmental suppression of pink salmon and Pacific herring following the oil spill. The goals of SEA were to understand and model numerically the physical and biological processes that influence pink salmon and herring production in Prince William Sound (PWS). In its closeout year, FY99, the major focus of the SEA program was synthesis and report and manuscript preparation. Many project reports and manuscripts have already been extensively reviewed and published. This proposal provides support only to complete the printing and distribution of the Final Report in FY02 according to the specifications in "Procedures for the Preparation & Distribution of Reports" (October 1998).

It had been planned to complete this action during FY 2000 and funding had been allocated to ADF&G for that task; however, completion of the report has been delayed and according to State of Alaska procurement rules, the encumbered funds cannot be spent after 30 June 2001.

NEED FOR THE PROJECT

A. Statement of the Problem

Successful completion of this multidisciplinary investigation requires peer authentication, printing, and distribution of the Final Report. Production of an integrated synthesis volume in a peer-reviewed journal has been funded separately; however, the final production of the Final Report still remains. This task is the responsibility of the Alaska Department of Fish and Game, however, no funds will be available after the FY2000 encumbrance has been allowed to lapse. In addition, assumptions about the size, content, format, and cost of the SEA Final Report have changed (e.g., postage); therefore, these assumptions need to be validated with FY2002 data.

B. Rationale/Link to Restoration

Knowledge gained through work of the SEA program is adding to the understanding of factors that may limit recovery of two injured species, pink salmon and herring. This project supports the publication of information that can be used by the Trustee Council and its member agencies to enhance management of these important commercial fishes, and by other projects studying linkages between forage fishes and higher level consumers, as part of the overall EVOS restoration effort.

C. Location

SEA was designed and implemented in Prince William Sound.

COMMUNITY INVOLVEMENT

The Final Report and the special synthesis volume will be available to people from affected communities, all agencies and to users of pink salmon and herring resources in PWS and elsewhere though the ARLIS Library archival and distribution activities.

PROJECT DESIGN

A. Objectives

Specific project objective is:

- To collate, print, bind and distribute the integrated SEA Final Report as required by the Trustee Council.

B. Methods

The Draft Final Report for the SEA project was to be assembled as part of the 00320Z2 project. After the integrated package of approved SEA Final Reports is approved by the Chief Scientist, it will be received, printed, bound and distributed at ADF&G Habitat and Restoration Division by Celia Rozen.

A total of 88 copies will be prepared including 33 for the required ARLIS distribution and 50 copies for SEA program members, PIs, senior scientists, technicians and students. The 33 copies of the Final Report that are intended for the required ARLIS distribution will be accommodated by this project. The 50 copies for SEA program members are scheduled to be published in Compact Disk (CD) format and have been included in the DPD and budget for the project Number 00320Z2, Sound Ecosystem Assessment (SEA): publishing the integrated Final Reports and a Program Synthesis.

The size, content, format and costs associated with the printing, binding and mailing of the SEA Final Report was estimated two years ago with planning assumptions that included completion by September, 2000. The budget included with this DPD is also based on those same assumptions. The actual size, content, format and costs associated with the printing, binding and mailing of the Final Report may be known before this DPD is reviewed and the budget may be adjusted as the planning assumptions are replaced with real data.

C. Cooperating Agencies, Contracts and Other Agency Assistance

The Final Report will be ready for printing and distribution after all of the components of the Draft Final Report are assembled and submitted for peer-review, pending approval by the Chief Scientist.

SCHEDULE

A. Measurable project tasks for FY00 (October 1, 2001 - September 30, 2002)

October, 2001 – Draft Final Report will have been submitted and peer reviewed.

December, 2001 – Peer-review comments are addressed and Final Report is approved and delivered.

March, 2002 – Final Report is printed, bound and mailed.

B. Project milestones and endpoints

The process detailed in this proposal will be completed when the Final Report package is printed and distributed to the EVOS Trustee Council and its agencies. The actual schedule may be amended if the delivery of the Draft Final Report and the Final Report are not delivered according to the expected schedule.

C. Completion Date

The publication of SEA Final Report closeout documentation is expected to be concluded in FY02.

PUBLICATIONS AND REPORTS

The approved Final Report for the SEA project will be printed, bound and mailed.

PROFESSIONAL CONFERENCES

None.

NORMAL AGENCY MANAGEMENT

N/A

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Publication tasks will be performed in close coordination with the SEA Lead Scientist, Dr. T. Cooney and the Restoration Office.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

N/A

PROPOSED PRINCIPAL INVESTIGATOR

Bill Hauser will serve as the PI of project 02320.

PRINCIPAL INVESTIGATOR

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Dr. Bob Spies and EVOS TC Restoration Office
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Revision 1:-01
approved TC 12-11-01

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel		$0.0
Travel		$0.0
Contractual		$2.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$2.0
General Administration		$0.1
Project Total	$0.0	$2.1
Full-time Equivalents (FTE)		0.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
Estimated FY 2003					
$0.0					

Dollar amounts are shown in thousands of dollars.

Comments:

Planning Assumptions :
- Manuscripts that were included in the Draft Final Report for the SEA Projects which are now published will be replaced by pages that list appropriate citations.
- The assembled Final Report will be scanned to create pdf files that will be available on the web.
- The size of the assembled Final Report is an estimated 500 pages.
- A total of 47 copies will be printed, bound and mailed. (This includes distribution to ARLIS, Chief Scientist, EVOS Office, and Project Leaders.)

FY02

Prepared:
wjh; 28 March 2001

Project Number: 02320
Project Title: Sound Ecosystem Assessment (SEA): Printing the Final Report.
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Personnel Costs:		GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FY 2002
Name	Position Description					
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.0	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 2002
Description					
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY02

Prepared:

Project Number: 02320
Project Title: Sound Ecosystem Assessment (SEA): Printing the Final Report.
Agency: Alaska Department of Fish and Game

FORM 3B
Personnel
& Travel
DETAIL

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:	Proposed FY 2002
Description	
Production costs for the SEA Final Report*	
Task	
Scan for B&W pdf files	40.00
Scan for color pdf files	10.00
Color Copies	550.00
Printing & Binding	1,350.00
Postage	85.00
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$2.0

Commodities Costs:	Proposed FY 2002
Description	
Commodities Total	$0.0

FY02

Prepared:

Project Number: 02320
Project Title: Sound Ecosystem Assessment (SEA): Printing the Final Report.
Agency: Alaska Department of Fish and Game

FORM 3B
Contractual & Commodities
DETAIL

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2002
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY02

Project Number: 02320
Project Title: Sound Ecosystem Assessment (SEA): Printing the Final Report.
Agency: Alaska Department of Fish and Game

FORM 3B
Equipment
DETAIL

Prepared:

TC approved 4-18-02
Amendment to 02423

Alaska SeaLife Center
windows to the sea

This is an amendment to 02423. Pls. copy & return ~~to~~ Sandra

To: Molly McCammon

From: Shannon Atkinson, PhD

Date: April 15, 2002

Re: Harlequin Duck Budget Adjustment

I believe that you are aware that the Harlequin ducks that were part of Dan Esler's project contracted a virus that has rendered them unreleasable. While the source of the virus will probably remain unknown, the situation became one of figuring out what to do with the birds. Dan and his graduate student handled the situation very well, as did the SeaLife Center staff, and the original project was completed successfully about a week ago.

In developing a future plan for these birds, several of us (Dr. Dan Esler, Dr. Pam Tuomi (ASLC senior vet), Dr. Tuula Hollmen (ASLC sea duck biologist and veterinarian) and myself) felt that as long as these birds were not going back to the wild, we ought to get the most information from them as possible. To this extent we have developed a plan that includes 3 small studies, at the end of which, the birds will be euthanized. Three of the worst affected birds have already been euthanized.

The first study is a refined reovirus study that will primarily take place at the National Wildlife Health Center (NWHC) in Wisconsin. Dr. Hollmen will take the lead on this, and 6 to 8 of the birds will be shipped to Wisconsin in May. The costs for the study are proposed to be shared between NWHC, ASLC and EVOS ($2600 requested for shipping the birds and holding them in WI, plus $150 for cages and $1590 for Dr. Hollmen to accompany the birds and initiate the virus study). Dr. Hollmen has also submitted an additional grant to cover the costs of analyses.

The second study is a feeding trial to determine the role of Vitamins K and E in a severe coagulopathy that was observed in 7 of 46 wild caught Harlequin ducks that were part of Dan's studies on the long term effects of crude oil exposure. This coagulopathy was observed in ducks housed at the Alaska SeaLife Center (ASLC) between September 2000 and February 2002 and appeared shortly after their arrival at ASLC. All of the birds will participate in this study. The costs for this study are again proposed to be shared between ASLC and EVOS ($6100 requested for vitamin analyses and a blood analyzer). Dr. Tuomi has also submitted another proposal to Oiled Wildlife Care Network to help defray the costs.

The third study is assessing stress in Harlequin ducks based on adrenal corticoid output. We are proposing to determine the circadian pattern of corticosterone production as well as assess the response to an ACTH stimulation. This study will be supported by UAF Wildlife Analytical Services (my endocrine lab located at ASLC) and ASLC. No costs have been requested from EVOS.

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www.alaskasealife.org

All of the above studies have undergone IACUC review and the birds will remain under Dan's ADFG and USFWS permits. The total duration is 2 months. We anticipate one publication to come from the reovirus study, with Dr. Hollmen as senior author. We expect another publication on the vitamin study, with Dr. Pam Tuomi serving as the senior author. An additional two publications are anticipated on the endocrine studies. While I will serve as the P.I. on those studies, Mr. Peter Nilsson will be using the data for his Master's thesis at UAF. Mr. Nilsson's research assistantship is being funded by me endocrine lab.

I have attached a budget, which includes the above mentioned costs, but also includes costs to feed ($1590) and care for the birds ($2628 personnel, $1000 lab supplies and health screenings) until the end of May. The costs to fumigate ($5000) the aviary and lab facilities utilized by Dan's original project and ASLC space rental ($2000) are also included. The original EVOS bench fees for this project were originally calculated to end on March 31, 2002, and did not include any costs for this unplanned virus.

Please review this situation as you need to and let me know of your decision. The virus was unfortunate and definitely unplanned; however I feel that all involved have gone beyond the call of duty to make the best of a bad turn of events. Thank you for your consideration. I will be available for any questions you may have on April 18, 2002.

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TC approved 6-18-02

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

Budget Category:	Authorized FY 02	Proposed FY 02	[redacted]
Personnel		$2,628.0	
Travel		$1,590.0	
Contractual		$13,200.0	
Commodities		$2,590.0	
Equipment		$2,650.0	LONG RANGE FUNDING REQUIREMENTS
Subtotal	$0.0	$22,658.0	Estimated FY 03
Indirect			
Project Total	$0.0	$22,658.0	
			[redacted]
Full-time Equivalents (FTE)			
			Dollar amounts are shown in thousands of dollars.
Other Resources			

Comments:

NOTE: ADF&G GA of $1,600 will be added to this project, bringing the total to $24,300.

FY02

Prepared: 4/16/02

Project Number: 02423 (amendment)
Project Title: Patterns & Processes of Population Change in Selected Nearshore Vertebrate Predators
Name: Alaska SeaLife Center

FORM 4A
Non-Trustee
SUMMARY

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 02
	Kelly Fielitz	Research Technician - Personnel	3.0	684.3		2,052.9
	Kelly Fielitz	Research Technician - Fringe benefits	3.0	191.6		574.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	6.0	875.9	0.0	
					Personnel Total	$2,627.7

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 02
	Roundtrip Anchorage to Wisconsin (3days/trip)	1000.0	1	3	130.0	1,390.0
	Car rental			3	50.0	150.0
	Other Travel expenses			1	50.0	50.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$1,590.0

FY02

Prepared:

Project Number:
Project Title:
Name:

FORM 4B
Personnel
& Travel
DETAIL

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

Contractual Costs:	Proposed
Description	FY 02
Health Certificates/screening 20 @ $30	600.0
Reovirus Accomodation and Analysis	2,000.0
Vitamin Analysis 48 @ $75	3,600.0
Fumigation/disinfection	5,000.0
Space Rental - ASLC	2,000.0
Contractual Total	$13,200.0

Commodities Costs:	Proposed
Description	FY 02
Lab Supplies	400.0
Animal Food (2 months)	1,590.0
Shipping - 3 cages @ $200/cage	600.0
Commodities Total	$2,590.0

FY02

Prepared:

Project Number:
Project Title:
Name:

FORM 4B
Contractual &
Commodities
DETAIL

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 02
Sigma Analyzer	1	2500.0	2,500.0
Cages	3	50.0	150.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$2,650.0

Existing Equipment Usage:	Number
Description	of Units

FY02

Prepared:

Project Number:
Project Title:
Name:

FORM 4B
Equipment
DETAIL

approved TC
19.11.05

Gulf Ecosystem Monitoring and Research Program Data System

Project Number:	02455
Restoration Category:	Monitoring and research
Proposer:	Restoration Office, *Exxon Valdez* Oil Spill Trustee Council
Lead Trustee Agency:	Restoration Office (ADFG)
Cooperating Agencies:	None
Alaska SeaLife Center:	No
Duration:	1st year, on going project
Cost FY 02:	$105,000
Geographic Area:	All
Injured Resource:	All

ABSTRACT

This project will initiate an ongoing data management and information transfer system for GEM (Gulf Ecosystem Monitoring and Research, the Trustee Council's long-term monitoring and research program currently under development). GEM is being designed to monitor the ecosystems of the northern Gulf of Alaska and the adjacent coastal regions for a very long time period. Data collection, archiving, transfer, delivery, and presentation are critical components of GEM. Project funding will be used to hire a data system manager to provide the leadership and expertise necessary for this essential part of the GEM program.

INTRODUCTION

In March of 1999 the Trustee Council decided to devote a large portion of the remaining settlement funds to a long-term monitoring and research program as part of the legacy of the *Exxon Valdez* oil spill. The draft GEM Program Document, which is currently under review by the National Research Council and scheduled for final adoption by the Trustee Council in Summer 2002, calls for clear and effective approaches to gathering information and making it widely available in understandable formats. The data collected with Trustee Council funds must be handled and stored in ways that ensure easy and efficient access by all users both now and in the future.

The GEM data policies incorporate ten broad elements (draft GEM Program Document, Vol. I, p. 71, August 2001):

1. A commitment to the maintenance and long-term availability of data.
2. Full and open sharing of data at low cost, after verification and validation.
3. Timely availability of data, depending on the type of data. Some data will be available almost immediately; other data may be available with 24 months.
4. Availability of data on the GEM public web site.
5. Identification of the origin of all data with a citation.
6. Adherence to data collection and storage standards.
7. Provision of citations to the GEM bibliography.
8. Encouragement of active participation in the GEM web site for all participants.
9. Long-term archiving of all data in a designated storage facility.
10. Acceptance of and adherence to the data policies as a condition for participation in the GEM program and receipt of funding.

Need for the Project

A. Statement of Problem

The Trustee Council established goals for the GEM program (April 2000) that make data management a top priority. The "Inform" goal states that the GEM program will provide integrated and synthesized information to the public, resource managers, industry and policy makers in order for them to respond to changes in natural resources. The "Solve" goal requires developing tools, technologies, and information that can help resource managers and regulators improve management of marine resources and address problems that may arise from human activities. The "Detect" goal also has a data management and communication aspect, as GEM is asked to serve as a sentinel (early warning) system by

detecting annual and long-term changes in the marine ecosystem, from coastal watersheds to the central Gulf of Alaska.

Many issues need resolving during the development stages of any data system, which requires a professional data system manager to provide guidance and direction in developing and implementing a successful system.

B. Rationale/Link to Restoration

In order to accomplish the Trustee Council's goals for the GEM program, management of monitoring and research data is a top priority. The purpose of this project is hire a GEM program data system manager to develop and implement a data system for GEM.

C. Location

The data system manager will work in the *Exxon Valdez* Oil Spill Trustee Council Office in Anchorage. The data manager will generally work under the supervision of the Science Director, although for some projects will work under the supervision of the Executive Director.

Project Design

A. Objectives

The Data Manager will work under the general direction and supervision of the Trustee Council's Science Director to:

- Implement and manage a data and information system consistent with the provisions of the GEM Program Document that provides data, information products (maps, tables, summary reports) and documentation for scientific researchers, resource managers, policy makers, and the public.
- Determine how best to incorporate existing and future data sets identified by the Science Director and other scientists into the data and information system.
- Chair a Data Advisory Group; serve as liaison to federal/state agencies, other research entities, principal investigators, other technical support personnel, as well as stakeholders and the general public.

Specific duties will include:

1. Develop a data policy that specifies how, when, and in what format data collected under the GEM program will be provided to GEM.
2. Develop data archiving policies and procedures.
3. Develop procedures for determining how, where, and for how long different kinds of data and metadata should be stored.
4. Develop GEM data standards that are consistent with federal, state, and industry standards.

5. Develop procedures and strategies for processing and using both existing and various types of new data (e.g., time series, taxonomic surveys, geographic locations of seabird colonies).
6. Develop procedures for QA/QC, including validation of GEM data sets.
7. Maintain Internet accessible databases of Trustee Council data and assist in enhancements to the Council's web page that allow access to GEM data and information.
8. Build solutions to manage complex scientific data, using existing software products (for both database systems and data analysis).
9. Account for integration, performance, and reliability of databases.
10. Network support for the Restoration Office, to the extent practicable.

B. Methods

N/A

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Technical data personnel from Trustee agencies and other research entities will be invited to serve on a data advisory group. The committee will assist in setting goals and policies for the GEM data system. The data group will also assist in the development of the data system and advise on how best to address the target user communities' needs and the scope of the system.

SCHEDULE

A. Measurable Project Tasks for FY 02 (October 1, 2001 – September 30, 2002)

April 10:	Data Manager begins work and development of data system

B. Completion Date

The data system will be an ongoing component of the GEM program.

PRINCIPAL INVESTIGATORS

Molly McCammon
Executive Director
Exxon Valdez Oil Spill Trustee Council
441 West 5th Ave., Suite 500
Anchorage, AK 99501
(907) 278-8012

molly_mccammon@oilspill.state.ak.us

Dr. Phil Mundy
Science Director
Exxon Valdez Oil Spill Trustee Council
441 West 5th Ave., Suite 500
Anchorage, AK 99501
(907) 278-8012
phil_mundy@oilspill.state.ak.us

PRINCIPAL INVESTIGATOR

Ms. McCammon has 25 years of experience in Alaska in recreation and tourism, journalism, communications, and public policy, emphasizing natural resource issues. She has been Executive Director of the Trustee Council since 1994.

Dr. Phil Mundy holds a Ph.D. in Fishery Science and has been Science Coordinator (now Science Director) for the *Exxon Valdez* Oil Spill Restoration Office since 1999. He brings 28 years of experience in computer science to the Data System project .

Approved TC

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$47.5						
Travel		$16.1						
Contractual		$20.0						
Commodities		$2.4						
Equipment		$10.5						
Subtotal		$96.5	Estimated FY 2003					
General Administration		$8.5						
Project Total	$0.0	$105.0						
Full-time Equivalents (FTE)		0.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

NOTE: $105.0 approved by TC 8/6/01 contingent on preparation and review of a Detailed Project Description and budget.

FY02

Project Number: 02455
Project Title: GEM Data System
Agency: Restoration Office (ADF&G)

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: March 15, 2002

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2002
						0.0
Bob Walker	Data Manager	22D	6.5	7.3		47.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		6.5	7.3	0.0	
					Personnel Total	$47.5

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2002
					0.0
					0.0
Travel for applicants' interviews					5.1
					0.0
Anchorage to Juneau	0.4	2	4	0.2	1.4
					0.0
Anchorage to Fairbanks	0.3	3	9	0.2	2.7
					0.0
Travel for Data Advisory Group					2.5
					0.0
Attendance at professional conference (Anchorage to WDC)	1.4	2	8	0.2	4.4
					0.0
				Travel Total	$16.1

FY02

Project Number: 02455
Project Title: GEM Data System
Agency: Restoration Office

FORM 3B
Personnel
& Travel
DETAIL

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:		Proposed
Description		FY 2002
Data support services (e.g., digitizing data, etc.)		5.0
Technical consultant services (web support, database development)		15.0
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$20.0

Commodities Costs:		Proposed
Description		FY 2002
Software, disks, etc.		2.4
	Commodities Total	$2.4

FY02

Project Number: 02455
Project Title: GEM Data System
Agency: Restoration Office

FORM 3B
Contractual &
Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2002
			0.0
			0.0
Computer and printer			5.0
Related computer equipment (e.g., enhanced web server)			5.0
Scanner			0.5
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$10.5

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY02

Project Number: 02455
Project Title: GEM Data System
Agency: Restoration Office

FORM 3B
Equipment
DETAIL

Approved TC 12-11-0

LOWER COOK INLET WASTE MANAGEMENT PLAN

Project Number:	02514
Restoration Category:	General Restoration
Proposer:	Tom Turner/ADEC on behalf of Lower Cook Inlet communities
Lead Trustee Agency:	Alaska Department of Environmental Conservation
Alaska SeaLife Center:	No
Duration:	1st yr., 2 yr. project
Cost FY 02:	$47,900 (Phase I)
Cost FY 03:	To be determined (Phase II)
Geographic Area:	Lower Cook Inlet
Injured Resource/Service:	Intertidal and subtidal organisms, nearshore seabirds, shorebirds, marine mammals; also recreation and subsistence

ABSTRACT

This project will promote recovery of injured resources and protect and enhance environmental quality in the lower Cook Inlet communities of Nanwalek, Port Graham, and Seldovia. In FY 99 (Project 99514), the Trustee Council funded development of a plan for a waste management program that identifies solutions to these three communities' waste management problems. The component of the plan proposed for EVOS funding relates primarily to used oil and household hazardous waste. In FY 02, this project will undertake the first phase of plan implementation, which will include site visits, training, and follow-up assistance visits by the Alaska Department of Environmental Conservation, in conjunction with the Kenai Peninsula Borough and the Chugach Regional Resources Commission, in regard to existing waste management equipment and procedures. Phase I will also include recommendations to the Trustee Council on any additional equipment needs, facility needs, and follow-up for possible funding later in FY 02.

INTRODUCTION

This project is designed to minimize marine pollution from land-based sources, and to promote the recovery of coastal resources damaged by the *Exxon Valdez* oil spill. Three communities impacted by the spill, Port Graham, Nanwalek and Seldovia in lower Cook Inlet, generate a variety of wastes typical of small towns. These include used oil from machines, generators and vessels and household hazardous wastes. These communities currently are building capacity for planning, equipment, training, and development of infrastructure to manage wastes in an environmentally sound manner. However, significant needs remain to be addressed. Consequently, wastes generated within the communities continue to produce a chronic source of pollution that not only hinders full recovery of the marine environment but also has a negative impact on the general quality of life.

Under Project 99514, the Alaska Department of Environmental Conservation (ADEC) contracted with Montgomery Watson to assess the waste management needs in Port Graham, Nanwalek, and Seldovia. These needs are summarized in the Lower Cook Inlet Waste Management Plan. Project 02514 will be the first phase of plan implementation. ADEC's Statewide Public Service/Compliance Assistance, in conjunction with the Kenai Peninsula Borough and Chugach Regional Resources Commission, will conduct site visits, training, and follow up assistance visits in each community. The site assessments will review the recommendations in the Montgomery Watson plan and the Stephl Engineering, LLC reviews of the plan. The site assessments will be specific to used oil collection and household hazardous waste in the communities.

There are some existing collection systems in place for used oil and household hazardous waste through the Kenai Peninsula Borough. However, the collection of household hazardous waste and used oil in these three communities has not been fully effective due to limited knowledge and training. ADEC's Statewide Public Service, with cooperation with the Kenai Peninsula Borough, will provide training on the handling of household hazardous waste and used oil. This training will build upon the existing Kenai Borough collection system while providing base knowledge in communities to implement the Lower Cook Inlet Waste Management Plan. All three communities will receive an initial site visit, training and a follow-up assistance visit.

In addition, ADEC's Statewide Public Service will make recommendations to the Trustee Council on additional activities and/or facilities to improve waste management in these three communities. These recommendations are expected by February 28, 2002 and will be presented to the Trustee Council for possible funding as Phase II in early spring 2002.

This project is modeled after the Prince William Sound Waste Management Plan (Project 96115) and the Kodiak Island Waste Management Plan (Project 99304) funded by the Trustee Council.

NEED FOR THE PROJECT

A. Statement of Problem

The communities of Seldovia, Nanwalek, and Port Graham generate a variety of waste streams that may be entering, degrading and preventing the recovery of the spill area. The project team from Montgomery Watson, based on field visits and on-site interviews, assessed existing waste management practices and problems with village leaders and facility managers. Community facilitators from the Chugach Regional Resource Commission as well as City and Tribal Council representatives provided crucial input and assistance to the assessment.

Findings from the plan include the following:

- Communities annually generate used lubricating oil of more than 1,000 gallons in Seldovia, 250 gallons in Port Graham, and somewhat less at Nanwalek. Communities want to collect and re-use expended oil to generate heat.

- Discharges of oily bilge water may adversely affect marine wildlife. There is an opportunity for a centralized facility for bilge water at Seldovia Harbor.

    - Existing collection facilities and systems could be improved and their use could be enhanced.

B. Rationale/Link to Restoration

Pollutants entering marine waters are affecting resources and human uses injured by the oil spill. Human population growth, industrial activities and waste disposal contribute pollutants from local sources. The specific activities in this project would strengthen the communities' technical capabilities and environmental management. The project is designed to increase the communities' control and responsibility for waste management in order to identify, prevent, or limit pollution sources and associated damage.

C. Location

The communities in this project are Nanwalek, Port Graham, and Seldovia, which were directly affected by the oil spill. They are located on the southern side of lower Cook Inlet and must be reached by air or ocean; none have roads that connect them to other communities. Nanwalek and Port Graham are connected by a rugged trail with seasonal access for small all-terrain vehicles.

These communities depend upon subsistence resources, commercial fishing, and future development of tourism for their livelihood. Local natural resources are key to the health and well being of the residents. All project efforts will be focused on environmental management improvements and enhanced capability in these three communities.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

People in the areas affected by the oil spill remain highly concerned about the health and recovery of their local natural resources. Each of the three communities has a Community Facilitator and is fully engaged in developing this project through the local governing council and community leaders. Several drafts of the Lower Cook Inlet Waste Management Plan were reviewed and discussed with each community prior to submittal to EVOS.

The Chugach Regional Resources Commission, which aids the environmental coordination needs of communities affected by the oil spill, will participate in the project, working closely with each community and ensuring that local concerns, knowledge, and needs are successfully addressed.

PROJECT DESIGN

A. Objectives

The overall objective of the project is to minimize marine pollution from land-based sources in Port Graham, Nanwalek, and Seldovia. The objectives of Phase I are to:

1. Conduct site visits, training, and follow-up assistance visits, with the participation of the Kenai Peninsula Borough and the Chugach Regional Resources Commission, in regard to existing used oil and household hazardous waste management equipment and procedures.

2. Develop recommendations to the Trustee Council on any additional equipment needs and follow-up (for a possible Phase II).

B. Methods

Conduct Site Assessments: The community site assessments/visits will review, assist and train the communities on used oil management, hazardous waste identification and handling procedures.

Develop Procedures: Procedures will be outlined for the operation and maintenance of equipment and the handling of used oil and household hazardous waste. Trainees will learn and work with more efficient means of managing the flow of used oil and household hazardous waste.

Conduct Training: Trainees will learn (a) the best method for storage, handling, filtering, record keeping and disposal procedures for used oil; (b) the advantages and disadvantages of used oil units and projected maintenance costs; (c) assembly and start-up procedures for Smart Ash Burners and the "do's and don'ts " of working with these units; (d) procedures for the proper routine maintenance of used oil burners, including changing oil filters, elimination of water, cleaning, etc.; (e) about household hazardous waste exchanges and other options to reduce household hazardous waste disposal costs; (f) maintenance procedures to reduce used oil leaks and spills; (g) routine inspections for residential home heating tanks, including repair of leaking fuel lines, valves and storage tanks, controlling spills and proper spill reporting procedures; and

(h) about the village's bulk fuel tanks in order to be able to detect a problem and to assist in the event of a spill situation. In addition, trainees will develop local procedures for residents to place their used oil in sheds and collection tanks, develop a community awareness program and teach residents how to prevent spills. Training will also include a site visit to Kodiak to review successful used oil collection centers in communities there; this will be a peer training opportunity with existing operators in Old Harbor and Ouzinkie.

Review Scrap Metal/Hazardous Material Procedures: Procedures to identify, remove and dispose of hazardous material in Scrap Metal Pile and junk vehicles will be reviewed.

Prepare Operating & Maintenance Manuals: O&M manuals will be prepared for used oil collection and household hazardous waste procedures.

Review Procedures to Identify, Store and Label Household Hazardous Wastes: Training will include how to read labels for proper identification of container contents, how to store similar materials together and separate from other possibly incompatible materials, and under what category to label materials for disposal.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Phase I of this project will be carried out in cooperation with the Kenai Peninsula Borough, the Chugach Regional Resources Commission, and the community governments of Nanwalek, Port Graham, and Seldovia.

SCHEDULE

A. Measurable Project Tasks (Phase 1 only)

Jan. 2002	Site visit to each community
Feb. 28, 2002	Submit recommendations on any additional equipment needs, facility needs, and follow-up to Trustee Council that might be addressed in a Phase II of the project
Jan-June 2002	Training and follow-up visits in each community

B. Project Milestones and Endpoint (Phase 1 only)

Phase 1

By 2/28/02:	Submit recommendations on any additional equipment needs, facility needs, and follow-up to Trustee Council
By 6/02:	Complete site visits, training, and follow-up visits in each community

C. Completion Date

Phase I will be completed by June 2002. Any additional phases (depending on Phase I recommendations regarding any additional equipment needs, facility needs, or follow-up) will be brought before the Trustee Council later in FY 02 and will likely continue into FY 03.

PUBLICATIONS AND REPORTS

A written set of recommendations regarding any additional equipment needs or follow-up will be submitted to the Restoration Office by February 28, 2002.

PROFESSIONAL CONFERENCES

No attendance at professional conferences is included in this proposal.

NORMAL AGENCY MANAGEMENT

The project is not a requirement of state statute or regulation. This project is similar to the Prince William Sound Waste Management Plan (Project 96115) and Kodiak Waste Management Plan (Project 99304) funded by the Trustee Council.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Because the Kodiak Waste Management Project (Project 99304) is in progress, there will be an opportunity to review and adapt lessons learned from that project. This will help ensure that full benefits to restoration can be achieved and sustained through project activities and community improvements in lower Cook Inlet.

EXPLANATION OF CHANGES IN CONTINUING PROJECT

Not applicable.

PROPOSED PRINCIPAL INVESTIGATOR

Tom Turner, Manager
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Alaska Department of Environmental Conservation
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OTHER KEY PERSONNEL

Patty Brown-Schwalenberg
Executive Director
Chugach Regional Resources Commission
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Approved 12-11-01

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$20.0						
Travel		$8.0						
Contractual		$11.9						
Commodities		$3.4						
Equipment		$0.8						
Subtotal	$0.0	$44.1	Estimated FY 2003					
General Administration		$3.8						
Project Total	$0.0	$47.9						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY02

Prepared: 11/30/01

Project Number: 02514
Project Title: Lower Cook Inlet Waste Management Plan
Implementation: Phase I
Agency: ADEC

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2002
						0.0
D. Marcolle			2.0	5.7		11.4
D. Lundine			1.5	5.7		8.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		3.5	11.4	0.0	
					Personnel Total	$20.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2002
					0.0
Site visits (3 each Seldovia, Port Graham, Nanwalek) (Marcolle & Lundine)	250.0	18	24	100.0	6.9
Peer training trip to Kodiak (Marcolle & Lundine)	325.0	2	4	100.0	1.1
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$8.0

FY02

Project Number: 02514
Project Title: Lower Cook Inlet Waste Management Plan
Implementation: Phase I
Agency: ADEC

FORM 3B
Personnel
& Travel
DETAIL

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:	Proposed FY 2002
Description	
Chugach Regional Resources Commission	11.4
Printing Used Oil promo.	0.5
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$11.9

Commodities Costs:	Proposed FY 2002
Description	
Miscellaneous tools (wrenches, screwdrivers, transfer pumps, valves, etc.)	1.5
NORA handouts	0.2
Evacuator pumps	0.1
Self-priming pumps	0.4
Miscellaneous connectors and pipes	0.4
Carrying case	0.3
Smart Media equipment	0.3
Reprints of Rural Used Oil info.	0.2
Commodities Total	$3.4

FY02

Project Number: 02514
Project Title: Lower Cook Inlet Waste Management Plan
Implementation: Phase I
Agency: ADEC

FORM 3B
Contractual &
Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2002
			0.0
Digital camera 4.0 mega pixel			0.8
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.8

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY02

Project Number: 02514
Project Title: Lower Cook Inlet Waste Management Plan
Implementation: Phase I
Agency: ADEC

FORM 3B
Equipment
DETAIL

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel		$6.5
Travel		$3.3
Contractual		$0.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$9.9
Indirect		$1.5
Project Total	$0.0	$11.4
Full-time Equivalents (FTE)		
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
Estimated FY 2003					

Dollar amounts are shown in thousands of dollars.

Comments:

FY02

Prepared:

Project Number: 02514
Project Title: Lower Cook Inlet Waste Management Plan
Implementation: Phase I
Name: Chugach Regional Resources Commission

FORM 4A
Non-Trustee
SUMMARY

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Personnel Costs: Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 2002
						0.0
CRRC rep (for community site visits and peer training trip to Kodiak)			8 days			2.9
						0.0
Stipends for 3 trainees (1 each from Seldovia, Port Graham, Nanwalek) for 8 days each at $150/day						3.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.0	0.0	0.0	
					Personnel Total	$6.5

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 2002
					0.0
Site visits (1 each Seldovia, Port Graham, Nanwalek) (CRRC representative)	250.0	3	6	100.0	1.3
Peer training trip to Kodiak (CRRC representative and 1 trainee each from Seldovia, Port Graham, Nanwalek)	300.0	4	8	100.0	2.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.3

FY02

Project Number: 02514
Project Title: Lower Cook Inlet Waste Management Plan
Implementation: Phase I
Name: Chugach Regional Resources Commission

FORM 4B
Personnel
& Travel
DETAIL

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:	Proposed FY 2002
Description	
Contractual Total	$0.0

Commodities Costs:	Proposed FY 2002
Description	
Commodities Total	$0.0

FY02

Project Number: 02514
Project Title: Lower Cook Inlet Waste Management Plan
Imlementation: Phase I
Name: Chugach Regional Resources Commission

FORM 4B
Contractual &
Commodities
DETAIL

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2002
Description			
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number of Units	
Description		

FY02

Project Number: 02514
Project Title: Lower Cook Inlet Waste Management Plan
Implementation: Phase I
Name: Chugach Regional Resources Commission

FORM 4B
Equipment
DETAIL

12-5-01
(deferred component)
approved TC 12-11-01

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	PROPOSED FY 2002 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
				$10.1				$17.4
Personnel	$0.0	$18.4						
Travel	$0.0	$0.0						
Contractual	$0.0	$5.0						
Commodities	$0.0	$1.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$24.4				Estimated FY 2003		
General Administration	$0.0	$3.1						
Project Total	$0.0	$27.5				$0.0		
Full-time Equivalents (FTE)	0.0	0.3						
			Dollar amounts are shown in thousands of dollars.					
Other Resources	$0.0	$0.0				$0.0		

Comments:
This budget includes funding for sample and data analyses for samples of Pacific herring that were collected and preserved during Fall and Winter 2001, contingent on development of methodology to successfully discriminate stocks of Pacific herring in the Gulf of Alaska. Samples will be processed only after approval of the methodology by the Chief Scientist and the Executive Director.

Project total: $52.9 approved Aug.
27.5 approved Dec.
$80.4

FY02

Prepared:
revised 5Dec01, wjh/to

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Lead Agency: ADFG

FORM 2A
MULTI-TRUSTEE
AGENCY
SUMMARY

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel		$3.9
Travel		$0.0
Contractual		$5.0
Commodities		$0.3
Equipment		$0.0
Subtotal	$0.0	$9.2
General Administration		$0.9
Project Total	$0.0	$10.1
Full-time Equivalents (FTE)		0.1
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 2003		
			$0.0		

Dollar amounts are shown in thousands of dollars.

Comments:

FY02

Prepared:

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Lead Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2002
						0.0
Michael Byerly	Fishery Biologist II	16A	0.3	4.0		1.0
	Final Reporting					0.0
						0.0
Joe Cashen	FWT II (otolith preperation for EA)	9J	0.8	3.6		2.9
FWT II, ADF&G Otolith Lab						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.1	7.6	0.0	
					Personnel Total	$3.9

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2002
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY02

Prepared:

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Lead Agency: ADFG

FORM 3B
Personnel
& Travel
DETAIL

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:	Proposed FY 2002
Description	
Contract for elemental analysis of 100 otoliths @ $50 apiece	5.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$5.0

Commodities Costs:	Proposed FY 2002
Description	
Supplies and expendables	0.3
Commodities Total	$0.3

FY02

Prepared:

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Lead Agency: ADFG

FORM 3B
Contractual & Commodities
DETAIL

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2002
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Personal computers	2	ADFG

FY02

Prepared:

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Lead Agency: ADFG

FORM 3B
Equipment
DETAIL

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel		$14.5
Travel		$0.0
Contractual		$0.0
Commodities		$0.7
Equipment		$0.0
Subtotal	$0.0	$15.2
General Administration		$2.2
Project Total	$0.0	$17.4
Full-time Equivalents (FTE)		0.2
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 2003		
			$0.0		

Dollar amounts are shown in thousands of dollars.

Comments:

FY02

Prepared:

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Agency: NMFS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2002
Ron Heintz	Fishery Research Biologist	GS/12/	0.7	7700.0		5.4
	Data analysis and report writing					0.0
Larry Holland	Chemist	GS/12	1.3	7030.0		9.1
	Fatty acid analysis					0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.0	14730.0	0.0	
					Personnel Total	$14.5

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2002
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY02

Prepared:

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Agency: NMFS

FORM 3B
Personnel
& Travel
DETAIL

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Contractual Costs:	Proposed FY 2002
Description	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed FY 2002
Description	
Solvents, gasses	0.4
Glassware	0.3
Commodities Total	$0.7

FY02

Prepared:

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Agency: NMFS

FORM 3B
Contractual & Commodities
DETAIL

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2002
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
GC/MS	1	NMFS
HPLC	1	NMFS
computers, analytical software	2	NMFS

FY02

Prepared:

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Agency: NMFS

FORM 3B
Equipment
DETAIL

TC approved 12-11-01

Exchange between Prince William Sound and the Gulf of Alaska. Submitted Under the Broad Agency Announcement.

Project Number:	02552-BAA
Restoration Category:	Research
Proposer:	Prince William Sound Science Center
Sponsoring Agency:	NOAA
Duration:	Three years
Cost FY 02:	$ 102,500
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pink salmon, Pacific herring

ABSTRACT

One of the least understood physical processes that influence the biological components of PWS is the exchange between the northern Gulf of Alaska (GOA) and Prince William Sound (PWS). The main objective of this proposal is to document the interannual variability in water mass exchange between PWS and the adjacent northern GOA at Hinchinbrook Entrance, and to identify mechanisms governing this exchange. Support is requested for continued deployment of an upward looking ADCP mooring in Hinchinbrook Entrance to create time series of velocities spanning three years. The mooring will be equipped with a CTD to create a time series of deep temperature (T) and salinity (S). To identify the dominant factors that govern PWS/GOA exchange, the mooring velocity and deep T/S time series will be combined with meteorological and physical data collected under other research programs in progress in PWSand the GOA.

INTRODUCTION

The Sound Ecosystem Assessment (SEA), funded by the EVOS Trustee Council from 1994 to 1999, was aimed at understanding physical and biological factors affecting pink salmon and Pacific herring survival on an ecosystem level. As part of the SEA study, an upward-looking acoustic Doppler current profiler (ADCP) mooring was deployed in Hinchinbrook Entrance from June through September 1995 and from September 1996 through May 1997. Time series of horizontal and vertical velocities were created for these two periods. The data were low-pass filtered (40 hour) to remove the tidal component.

At Hinchinbrook Entrance, the summer and early fall months of 1995 (June through September) were characterized by outflow above about 150m and inflow below (Vaughan et al., 1999). Easterly offshore winds caused surface Ekman layer inflow, accompanied by deeper outflow. Except for the Ekman inflow, which reached speeds greater than 80 cm/sec, the magnitude of the flow seldom exceeded 20 cm/sec. In late September, at the very end of the 1995 time series, the pattern seemed to reverse to one of inflow above about 150m and outflow below.

The fall and early winter months (September 1996 through January 1997) at Hinchinbrook Entrance were characterized by inflow above 150m and weak outflow below. The magnitude of the inflow often exceeded 60cm/sec. The change to the opposite baroclinic structure in September could be a regular seasonal event, or indicate different conditions in 1995 and 1996. Late winter and spring months (January through May 1997) were characterized by more barotropic inflows and outflows (Vaughan et al., 1998). Speeds during this time were the weakest observed, typically less than 20cm/sec. The mechanisms responsible for the observed variability have not been identified. Offshore wind forcing or flows through the deep trench southeast of Montague Island may influence the vertical structure at Hinchinbrook Entrance.

Along channel transports through Hinchinbrook Entrance were calculated from the 1995 and 1996-1997 time series for layers above and below 150m, and compared to transports from 1978 (Niebauer et al., 1994). Trends in the monthly mean transports were similar above and below 150m for both time periods. In the upper layer, maximum inflows occurred in October and December, although the magnitudes in 1978 (0.3 Sv) were slightly greater than in 1996 (0.2 Sv). Above 150m, weaker outflows occurred in summer 1995 and in summer 1978. Below 150m, weak inflow occurred in summer 1995 and in summer 1978.

In December 1999, the ADCP mooring was redeployed in Hinchinbrook Entrance under EVOS project 00552. The mooring was retrieved in July 2000, but the ADCP failed to record any data. The problem (a bad chip in the ADCP deck box) was identified and corrected, and the mooring was redeployed in September 2000. A series of in-water tests were performed prior to deployment to insure the instrument was functioning properly. The mooring is scheduled for retrieval in May 2001, and for redeployment in September 2001. This proposal is for continued support of the Hinchinbrook mooring deployment.

This project will interface with other projects underway in PWS. GLOBEC Northeast Pacific (NEP) monitoring surveys in the northern GOA are scheduled to continue in FY00 through FY04. Process studies in the northern GOA are scheduled for FY01 and FY03. A GLOBEC survey line of particular interest is the trench on the southeastern side of Montague Island, which runs from the western side of Middleton Island to Hinchinbrook Entrance, and is almost certainly the conduit of any dense water entering PWS.

Anther project underway in PWS is the development of a near real-time nowcast/forecast (N/F) system, co-sponsored by the Oil Spill Recovery Institute (OSRI), the Alyeska Ship Escort and Response Vessel System (SERVS), and the PWS Region Citizens Advisory Council (PWS RCAC). The main objective of this project is to develop a prototype N/F circulation model that will be capable of calculating current velocity vector fields, particle trajectories, and the evolution of passive drifter concentrations. Current data are collected using a downward looking ADCP towed from one of the Alyeska SERVS vessels. East-west and north-south transects through central PWS, and repeated transects at Hinchinbrook Entrance (to eliminate the tidal contribution), were conducted in 1999 and 2000. Funding has been secured to continue measurements in 2001.

NEED FOR THE PROJECT

A. Statement of the Problem

Mechanisms governing exchange between the northern GOA and PWS are not well understood. It is not clear quantitatively what controls the amount of throughflow at Hinchinbrook Entrance, or how the throughflow affects the circulation in PWS. In particular, it is not known what causes the baroclinic structure in summer and early fall, the apparent reversal of this structure in September, and the transition to a barotropic structure in winter. The Hinchinbrook Entrance velocity data collected during the SEA program revealed significant spatial (horizontal and vertical) and seasonal variability of the throughflow. Documenting the interannual variability of the currents at Hinchinbrook Entrance and identifying the mechanisms that govern the exchange will require a time series of velocity at all depths that spans several years.

B. Rationale/Link to Restoration

Juvenile fish in PWS rely on zooplankton as their food source. Exchange at Hinchinbrook Entrance could either seed PWS with zooplankton or flush zooplankton out, thereby regulating the amount of available food and possibly the number of copepods diapausing in PWS in winter. Exchange at Hinchinbrook Entrance may influence the central Sound circulation, and possibly the transport of juvenile fish from one nearshore region to another.

C. Location

This project has been designed for Prince William Sound. All communities that utilized the marine resources of Prince William Sound will benefit from this research.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Bids will be solicited from the private sector for oceanographic charters in FY01. This project will contribute information to local newsletters and newspaper articles. Results will be published in peer reviewed scientific journals. Results will be posted on a PWSSC web page, and will be accessible to the public.

PROJECT DESIGN

A. Objectives

The main objective of this proposal is to document the interannual variability in water mass exchange between PWS and the northern GOA at Hinchinbrook Entrance, and to identify mechanisms governing this exchange. Funding is requested for continued deployment of an upward looking ADCP mooring in Hinchinbrook Entrance in FY02. In addition to the ADCP velocity time series, time series of deep temperature (T) and salinity (S) will be collected by a CTD mounted on the mooring.

B. Methods

An upward-looking ADCP mooring (RDI 150 kHz broadband) will be deployed in the fall of each year (e.g., September) and retrieved in the spring or summer (e.g., May). The approximate mooring location will be latitude 60 17.0', longitude 146 51.0', which is in the deepest part of Hinchinbrook Entrance at the northern end of the Montague Island trench. As configured, the ADCP will measure horizontal and vertical velocities from a few meters above the transducer faces to within roughly 45m of the surface in 8m bin depths. To maximize deployment time while still capturing the tidal cycle, the sampling interval will be 2 hours.

The data will be processed using standard RDI software and analyzed using software developed under SEA. The horizontal velocities will be translated into along-channel and cross-channel components, and 40 hour low-pass filtered to remove the tidal components. Transports will be calculated from the along-channel low-pass filtered velocities above and below 150m (as well as other depth intervals) and compared to previous years' values. Power spectra for each component will also be calculated at several depths and compared to previous years.

In addition to the velocity data, T/S data will be collected by a SeaBird 16 CTD mounted on the mooring. The instrument has been equipped with a new pressure housing enabling

it to function at the mooring depth. The data will be processed using standard SeaBird software. Density will be calculated from T and S.

The velocity and T/S data will be stored on the PWSSC network computers. Analyzed data products will be available via a PWSSC web site. Raw data will be available to other EVOS investigators after publication.

With a 2 hour sampling interval, continuous data collection is limited by battery power to approximately 9 months. The second deployment took place in September 2000. In FY01, retrieval is scheduled for May 2001, and redeployment for September 2001. In FY02, the final retrieval is scheduled for May 2002.

It is unfortunate that this collection strategy does not include measurements in the summer months. Previous summer observations at Hinchinbrook Entrance have revealed many interesting features. September and May were chosen for several reasons. With a maximum 9 month deployment time, a single mooring will miss 3 months of the year. Since severe weather often precludes shipboard work in the late fall through early spring, the summer months were chosen to miss. In the summer, the mooring time series will be supplemented by velocity measurements using a towed shipboard instrument as described below. Conditions in both September and May are usually mild enough to allow mooring work. Also, this time period covers the late fall and early winter when volume transports at Hinchinbrook Entrance are maximum. Efforts are underway to secure funding for a second mooring, so that year-round measurements will be possible.

Target cruise dates for years 2001 and 2002 are:

May 2001	(retrieval)
September 2001	(deployment)
May 2002	(retrieval)

FY01 included two mooring cruises (May 2001 and September 2001). FY02 will include one mooring cruise (May 2002) unless continued funding makes additional deployments possible. A vessel with a crane, A-frame, or other equipment suitable for mooring deployments will be required.

To identify the dominant factors that govern PWS/GOA exchange, the mooring velocity and deep T/S time series will be combined with additional data types collected under other programs. The time series obtained from the mooring will be supplemented by the velocity transects made with a downward-looking towed ADCP (funded under the OSRI N/F project). The repeated transects will capture the spatial variability of the Hinchinbrook Entrance flow patterns. T/S measurements on the SERVS cruises will be obtained using expendable CTDs (XCTDs). Conditions in the GOA, particularly in the trench southeast of Montague Island, will be documented by the GLOBEC group at the Institute of Marine Science (IMS) at the University of Alaska Fairbanks (UAF). Meteorological data are available from the NOAA NDBC stations, particularly the Seal Rocks and Mid-Sound buoys, and from the FAA station located on Middleton Island.

The numerical circulation model developed by the OSRI N/F modeling group at the University of Miami (UM) Rosenstiel School of Marine and Atmospheric Science (RSMAS) will be used in conjunction with the observations to identify mechanisms governing PWS/GOA exchange.

The mooring velocity time series coupled with the repeated ADCP transects over multiple years will show whether the baroclinic inflow/outflow structure that dominated the flow in summer 1995 and in fall through early winter 1996 (including the apparent September reversal and the 150m separation depth), as well as the transition from a baroclinic to barotropic structure in January 1997, is typical or anomalous. The mooring velocity time series coupled with time series of wind from the meteorological buoys will allow further investigation of surface Ekman layer inflow.

The T/S time series will signal the movement of any new deep water mass into or out of PWS. T/S observations from the GLOBEC cruises should reveal the source of deep water flowing into PWS, or the southern extent of deep water flowing out of PWS. Time series of GOA wind speed and direction (from the Middleton Island station) should indicate if large scale atmospheric forcing in the Gulf is responsible for the inflow/outflow patterns and transitions at Hinchinbrook Entrance, and for the variability in transports above and below 150m.

C. Cooperating Agencies, Contracts and Other Agency Assistance

Cooperating agencies will be OSRI, PWS RCAC, and Alyeska SERVS.

SCHEDULE

A. Measurable Project Tasks

FY01:

April 15, 2001:	FY00 Annual Report due
May 2001:	Mooring retrieval
September 2001:	Mooring deployment

FY02:

January 2002:	EVOS Workshop - Anchorage
April 15, 2002:	FY01 Annual Report due
May 2002:	Mooring retrieval

FY03:

April 15, 2003:	FY02 Final Report due

B. Project Milestones and Endpoints

Milestones of each year will be the successful deployment and retrieval of the mooring. The endpoint of each fiscal year will be marked by the Annual Report due date (April 15 of 2001, 2002 and 2003).

C. Completion Date

All project objectives will be completed in FY02 except for submission of the final report. The completion data of this project is September 30, 2003.

PUBLICATIONS AND REPORTS

The following manuscripts are in review and are expected to be published in FY01:

Physical Variability in Prince William Sound during the SEA Study (1994 - 1998), Fisheries Oceanography, March 2001. (This manuscript was previously entitled Physical Processes Influencing the Pelagic Ecosystem of Prince William Sound).

Seasonal Hydrography and Tidal Currents of Bays and Fjords in Prince William Sound, Alaska, March 2001.

PROFESSIONAL CONFERENCES

Travel is requested to attend the EVOS Workshop in Anchorage. Travel is also requested to present results at the American Geophysical Union (AGU) Ocean Sciences Meeting in February 2002.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will be coordinated with the efforts Dr. T. Weingartner and Dr. D. Musgrave, both of IMS/UAF (GLOBEC), and with Dr. C. Mooers and Dr. I. Bang, both with UM/RSMAS (OSRI N/F). This project will cooperate with other EVOS sponsored programs to provide the most efficient means for investigating biological and environmental factors common to all projects.

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

Shari L. Vaughan, Ph.D.
Physical Oceanographer, Prince William Sound Science Center
(P.I. of SEA Physical Oceanography project 320-M)

Education:
B.S., University of Miami, May 1981, Physics (major)/Mathmatics (minor)
M.S., University of Miami, May 1986, Physics
Ph.D., University of Miami, Rosenstiel School of Marine and Atmospheric Science (RSMAS), May 1993, Meteorology and Physical Oceanography (MPO), Kevin D. Leaman, advisor

Professional Experience (since 1986):
1986 - 1993: Research Assistant, University of Miami, RSMAS, MPO, Miami, Florida
1993 - 1995: Postdoctoral Associate, University of Miami, Cooperative Institute for Marine and Atmospheric Studies, a cooperative institute between RSMAS and NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML), Miami, Florida, Robert L. Molinari, supervisor
Sept. 1995 - present: Physical Oceanographer, Prince William Sound Science Center, Cordova, Alaska

Recent Refereed Journals:
Vaughan, S. L. and K. D. Leaman, 1995: The Role of Small-Scale Cells in the Mediterranean Convection Process. J. Phys. Oceanogr., 25 (10), 2423-2436.

Vaughan, S. L. and R. L. Molinari, 1997: Temperature and Salinity Variability in the Deep Western Boundary Current. J. Phys. Oceanogr., 27 (5), 749-761.

Vaughan, S. L., C. N. K. Mooers, and S. M. Gay III, 2001: Physical Variability in Prince William Sound during the SEA Study (1994-1998). J. Fish. Oceanogr. (submitted).

Gay III, S. M. and S. L. Vaughan, 2001: Seasonal Hydrography and Tidal Currents of Bays and Fjords in Prince William Sound, Alaska. J. Fish. Oceanogr. (submitted).

OTHER KEY PERSONNEL

Shelton M. Gay: cruise staging, instrument calibration and maintenance, data acquisition and analysis, contribute to journal publications.

LITERATURE CITED

Niebauer, H.J., T.C. Royer, and T.J. Weingartner, 1994: Circulation of Prince William Sound, Alaska. J. Geophys. Res., 99, C7, pp 14,113-14,126.

Vaughan, S.L., S.M. Gay, L.B. Tuttle, and K.E. Osgood, 1998: SEA: Observational Oceanography in Prince William Sound. Exxon Valdez Oil Spill Restoration Project Annual Report (Restoration Project 97320-M), Prince William Sound Science Center, Cordova, Alaska.

Vaughan, S.L., C.N.K. Mooers, J. Wang, S.M. Gay, and L.B. Tuttle, 1999: Physical Processes Influencing the Pelagic Ecosystem of Prince William Sound. Exxon Valdez Oil Spill Restoration Project Annual Report (Restoration Project 98320-M), Prince William Sound Science Center, Cordova, Alaska.

approved 12-11-01

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel		$0.0
Travel		$0.0
Contractual		$95.8
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$95.8
General Administration		$6.7
Project Total	$0.0	$102.5
Full-time Equivalents (FTE)		0.6
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Dollar amounts are shown in thousands of dollars.

Comments:

FY02

Prepared:

Project Number: 02552-BAA
Project Title: Exchange between PWS and the Gulf of Alaska
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Budget Category:	Authorized FY 2001	Proposed FY 2002

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel		$55.1
Travel		$6.1
Contractual		$11.8
Commodities		$2.2
Equipment		$0.0
Subtotal	$0.0	$75.2
Indirect (27.43%)		$20.6
Project Total	$0.0	$95.8
Full-time Equivalents (FTE)		0.6

LONG RANGE FUNDING REQUIREMENTS

Dollar amounts are shown in thousands of dollars.

Other Resources								

Comments:

FY02

Prepared:

Project Number: 552
Project Title: Exchange between PWS and the Gulf of Alaska
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

Personnel Costs:			Months Budgeted	Monthly Costs	Overtime	Proposed FY 2002
Name	Position Description					
Shari Vaughan	Physical Oceanographer (PI)		3.8	8300.0		31,540.0
elton Gay	Physical Oceanographer		3.8	6200.0		23,[illegible]

						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		7.6	14500.0	0.0	
					Personnel Total	$55.1

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2002
	EVOS Workshop - Anchorage - January 2002	220.0	1	3	145.0	655.0
	1 r/t Cordova-Fairbanks	460.0	1	3	145.0	895.0
	1 r/t Cordova-Miami	960.0	1		0.0	960.0
	1 r/t Miami-Cordova	960.0	1	4	145.0	1,540.0
	AGU Ocean Sciences Mtg. - Honolulu - Feb. 11-15, 2002	980.0	1	6	171.0	2,006.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$6.1

FY02

Prepared:

Project Number: 552
Project Title: Exchange between PWS and the Gulf of Alaska
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FY 2002
Vessel Charter (1cruise, 2 days each @ $3000 per day)	6,000.0
Equipment calibration/repair	1,000.0
Network costs and maintenance ($100/computer-month)	1,600.0
Professional servies - mooring technician ($2000 per cruise)	2,000.0

Phone, fax, copying	600.0
Mail, freight, shipping	600.0
Contractual Total	$11.8

Commodities Costs:	Proposed
Description	FY 2002
Office supplies	600.0
Computer supplies	600.0
Marine supplies	1,000.0
Commodities Total	$2.2

FY02

Prepared:

Project Number: 552
Project Title: Exchange between PWS and the Gulf of Alaska
Name: Prince William Sound Science Center

FORM 4B
Contractual & Commodities DETAIL

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

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2002
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	

FY02

Prepared:

Project Number: 552
Project Title: Exchange between PWS and the Gulf of Alaska
Name: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

Mapping Marine Habitats: Kachemak Bay

Project Number:	02556
Restoration Category:	Monitoring
Proposer:	C. Schoch/Kachemak Bay NERR
Lead Trustee Agency:	ADFG
Cooperating Agencies:	None
Alaska SeaLife Center:	No
New or Continued:	New
Duration:	1st yr. 1 yr. project
Cost FY 02:	$62.6
Cost FY 03:	$20.0
Geographic Area:	Kachemak Bay, Lower Cook Inlet
Injured Resource/Service:	Subtidal and intertidal communities

ABSTRACT

Groups, individuals, and programs as diverse as natural resource agencies, local governments, researchers, conservation advocates in Cook Inlet and Kachemak Bay, and GEM can benefit from a comprehensive, high resolution database of the shoreline and nearshore habitats of Kachemak Bay. This project will conduct intensive high-resolution field mapping of the nearshore habitats, by quantifying the physical attributes that force variability in animal and plant populations.

INTRODUCTION

The overall purpose of our proposal is to develop a statistically rigorous monitoring program in Kachemak Bay and lower Cook Inlet to address the needs of resource managers, researchers, conservation groups, local governments, and oil spill prevention/restoration organizations. This proposal seeks funding to build a spatially comprehensive database of the geomorphology and physical attributes of subtidal and intertidal habitats for the greater Kachemak Bay/Lower Cook Inlet area. We regard this as the foundation for developing a monitoring program to detect changes in nearshore communities resulting from shifts in watershed and marine processes. The NOAA Environmental Sensitivity Index (ESI) maps, developed for oil spill response planning, do not contain the data necessary for resolving small spatial scale features of the shoreline needed in ecological studies where biophysical linkages often occur at scales of less than one meter.

This project is linked to FY02 EVOS proposal #02565. While this project can be conducted independently, the cumulative value of these projects being undertaken simultaneously is great.

NEED FOR THE PROJECT

A Statement of Problem

The ecology of the nearshore benthos (from intertidal to 10 m depth) has been studied in detail at many coastal locations in the U.S. However, the processes that couple the intertidal regions with those in the nearshore ocean are poorly understood. For example, it is not apparent if production in some intertidal communities is regulated by the delivery of nutrients from the coastal ocean or by drainage from nearby rivers and estuaries (Menge et al., 1997). Such "edge" communities at the transition between one regime and another have rarely been studied as an integrated system. However, it is clear that there is strong physical and biological coupling between the nearshore and the intertidal (Schoch and Dethier, 1996). Prediction of how these communities will change over time or space is still a significant challenge. Map data of dominant habitats and species, as well as statistics about abundance, are important to our understanding of how these systems interact and function and have many applications in resource management as well as basic research. Such understanding is especially critical as we try to make predictions about impacts of large-scale environmental phenomena, from coastal eutrophication, to oil spills, to shifts in weather patterns and wind driven processes (ENSO and global climate change).

The planet is experiencing an unprecedented loss and impoverishment of its biological wealth as measured by species extinctions and degradation of its ecological systems (Schoch, 1998). Benthic organisms within the marine nearshore ecosystem are sensitive to environmental gradients and may serve as indicators of changes occurring in the coastal ocean. These benthic communities often include organisms with life spans ranging from days to seasons or years, and they frequently occur in large numbers, thus providing an attractive baseline for statistical analyses. For these reasons, and logistical accessibility, detecting change in nearshore biological communities is a key component of experimental ecological research and applied monitoring programs. But quantifying the distribution, abundance, and diversity of nearshore organisms over large spatial scales is

problematic for scientists and resource managers. Monitoring biological communities for a response to natural or anthropogenic perturbations encounters two fundamental problems. The first is the large temporal and spatial variability of organism abundances in natural ecosystems, which masks our ability to statistically separate an actual change caused by a perturbation from natural cycles. Second, extrapolating or generalizing the results of localized studies to broad areas is fraught with problems; yet biological sampling is too labor-intensive to attempt everywhere (Underwood & Petraitis 1993). One solution in the marine realm involves systematic quantification and minimization of physical gradients among sample sites.

B. Rationale/Link to Restoration

A method developed in Alaska by the principal investigator partitions complex shorelines into physically homogeneous segments. Groups of physically similar segments can then be aggregated into groups of replicates that allow more rigorous monitoring of the marine environment. This method has been successfully applied to shorelines in Kenai Fjords, Lake Clark (Schoch and Chen, 1995; Schoch, 1996), Katmai (Schoch 1994), and Glacier Bay National Parks: http://www.nps.gov/glba/learn/preserve/projects/coastal/. The database is now in use by the Olympic Coast National Marine Sanctuary (Schoch 1999) for the basis of a marine reserve network design, resource agencies in Puget Sound (Schoch and Dethier, 1998) for ecological modeling, and by the Partnership for Interdisciplinary Studies of the Coastal Ocean (PISCO: www.piscoweb.org) along the western U.S. (Schoch et al., 2000a, 2000b) for monitoring and comparing biodiversity at nested spatial scales. Monitoring across replicates increases the statistical power of ecological data by minimizing the variability of the biological community caused by physical forces. This method is proposed for implementation in Kachemak Bay as a first step in monitoring the changes in marine and estuarine physical and biological diversity. The method can be applied anywhere as the foundation for a statistically sound, scientifically defensible monitoring program.

With respect to the link to restoration effort, this project is proposed under the strategy "Ecosystem Synthesis/GEM Transition." This project is best linked to New Projects: Innovative Tools and Strategies for Improving Monitoring." ADFG encourages the Trustees to fund this project this year because it will answer key resource questions and lay the foundation for the development of an intertidal component of the GEM program. Moreover, the proposed research and monitoring effort will help leverage NOAA funds to establish and maintain a long-term oceanographic monitoring program in the Kachemak Bay/Lower Cook Inlet area.

Kachemak Bay is a NOAA National Estuarine Research Reserve (NERR). The NERR system has 26 sites throughout the United States that are dedicated to research and education of the marine/terrestrial interface of estuarine ecosystems. These reserves are a partnership between individual states and NOAA, so that each reserve is allocated approximately 70% of their funding for basic operations from the federal government. The remaining 30% of the funding must come from non-federal sources.

The NERR site in Kachemak Bay, called the Kachemak Bay Research Reserve (KBRR), is well situated to begin studies on coastal ecosystem dynamics. Kachemak Bay is located at the interface

between land and ocean waters and thus near the juncture of major oceanographic and land-based processes. The interaction of these forces is the major focus of the research being conducted by KBRR. The KBRR is developing models to understand the variability of factors driving primary productivity in the bay and specifically, the linkages and interactions of water delivered from the offshore ocean and surrounding watersheds. Watershed influences on the intertidal and other habitats in the Bay range from freshwater input, transport of nutrients, sediments and contaminants to topographic influences on winds and precipitation amounts and rates. Changes in watershed vegetation cover due to urbanization, spruce bark beetle infestation, logging and forest fires will alter transport dynamics and nutrient cycling, and thus the habitat quality and structure of biological communities in the intertidal and other habitats. Oceanographic processes, working from the other end of the ocean-bay-shore continuum, influence nutrient transport, life history dispersal mechanisms of plants, invertebrates and fishes, sediments and contaminants. The NERR system has a research mandate to develop a national time series of water chemistry from which natural variability and long-term changes can be measured over different spatial scales. As part of this system, the KBRR has a program to continuously measure seasonal oceanographic water characteristics including nutrients, phytoplankton, temperature and salinity at two stations in the Bay (Homer and Seldovia) as part of the national System Wide Monitoring Program (SWMP). These sensor arrays measure water temperature, conductance, salinity, pH, turbidity, dissolved oxygen, depth, PAR, and fluorescence on a continuous basis.

If successful, this proposal (along with proposals #02565 and #02569) will provide the KBRR with the required matching funds to receive additional support from NOAA to: (1) maintain and operate the exisiting monitoring program (e.g., pay for staff time to operate and maintain the oceanographic sensors); (2) expand the instrument array by adding two additional stations in Halibut Cove and Bear Cove; and (3) operate and maintain the more comprehensive monitoring program. Without these funds, the KBRR will mostly likely not be able to meet the required 30% non-federal match requirement and will have to decline the NERR operation funds that would be used to develop and run this monitoring program.

C. Location

This project will take place in Kachemak Bay: the north shore from Anchor Point to the Fox River, then the south shore from Fox River to Nanwalek. The project will benefit all the resource management agencies in the Bay, oil spill advisory councils, conservation agencies, and local governments (see attached letters of support). The communities include City of Homer and greater Homer area, Anchor Point, Seldovia, Port Graham, Nanweluk, and small unorganized communities on the south shore or Kachemak Bay (Halibut Cove, Jakalof Bay, Bear Cove). The benefits of this project will have broader application if these tools, technologies, and monitoring approaches are applied to other areas affected by the spill.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

The KBRR is an integrated research and education program. A goal of KBRR education program is to provide for community involvement and conduct educational programs that will interpret and instruct the public on research projects conducted in the region. While this project does not have

an explicit community involvement/data gathering component in this FY02 proposal, the KBRR will interpret research results by the following means:

- The KBRR web page;
- The KBRR interactive research and education programs;
- Conferences, workshops, and presentations on our programs to the community and schools;
- Display information on research projects at KBRR facilities and/or with partner organizations such as the Pratt Museum
- The results of this project, the GIS database, may have application with developing school monitoring programs.

The Olympic Coast National Marine Sanctuary is already employing a similar database developed by Dr. Schoch as an integral component for their teacher education program. The Sanctuary educators on the West Coast wish to link Olympic Coast Washington teachers and students with teachers, communities and students in Kachemak Bay, Alaska, with hopes to also link with other west coast Sanctuaries in California using this same model and protocol. This proposed research project will play an important role in laying the foundation for future public education and citizen monitoring efforts.

PROJECT DESIGN

A. Objectives

The objective of this proposal is to augment the long-term NOAA programs in ocean physics and chemistry in Kachemak Bay by adding an ecological component to address issues identified in the GEM Science Plan and by National Academy of Sciences reviewers. We propose to use subtidal and intertidal monitoring protocols developed by PISCO in Washington, Oregon, and California in Kachemak Bay. To that end, we envision being the ecological endpoint to a series of monitoring sites that now stretch from Mexico to Canada. By establishing water column, subtidal, and intertidal monitoring programs, using standardized protocols of the NERRS and PISCO, we will be able to make meaningful comparisons of data across multiple spatial scales to address issues of change locally and globally. The first step in the monitoring program is to inventory and map the benthic habitats in Kachemak Bay. In terms of identifying characteristic habitat types, rare habitats, and habitat diversity, these data will be required in order to determine the best locations for monitoring sites and to establish an ecological context to the habitats chosen for monitoring. Monitoring marine habitats relies largely on understanding where the larval sources are in relation to the populations and communities being monitored. Other issues include how and where larvae move at different times of the year, what habitats are used by which organisms at what periods of their life cycles, etc. The sources and movements of larvae in the Bay are not the

focus of this proposal, but it is necessary for reviewers to understand that these components of the ecosystem are not being overlooked.

We propose to map the nearshore habitats in Kachemak Bay and quantify the *physical attributes* that force spatial variation in diversity of fish, invertebrate, and algal populations among the various habitat types in the Bay.

B. Methods

The approach for minimizing biological variability (thus increasing statistical power to detect change) is to adopt a highly stratified sampling design based on the physics of the nearshore environment. We will use the protocols developed by PISCO to segment complex biogeochemical shoreline gradients using a combination of qualitative and quantitative partitioning criteria. Previous studies have often failed to develop quantitative links between specific intertidal assemblages and physical attributes of habitats, thus making it impossible to "scale up" in either time or space from limited *in situ* sampling (Menge et al., 1997). The proposed shoreline partitioning model addresses the needs of coastal ecologists seeking to make comparisons among spatially independent beach sites. This model relies on quantification of physical features known to have direct and indirect ecological responses, and uses these as criteria for partitioning complex shorelines into a spatially nested series of homogeneous segments. For example, at small spatial scales the quantified geophysical parameters include sediment grain size, wave energy, substrate dynamics, and sediment chemistry. At large spatial scales water chemistry attributes such as salinity, chlorophyll and nutrient concentrations are used. These nested segments can be used to study between-segment and within-segment variability, which in turn will support studies of the biotic and abiotic processes that control variability. This segment approach allows large areas of shoreline to be classified based on relatively limited *in situ* sampling. The results of previous research by the principal investigator in Alaska (Lake Clark, Kenai Fjords, Katmai and Glacier Bay National Parks) have shown this to be a robust approach, despite the enormous complexity of these regions (Schoch & Dethier 1996). An additional use of this database has recently been developed through an Olympic Coast National Marine Sanctuary initiative to establish a marine reserve network on the outer Washington coast.

The proposed study site will include all of Kachemak Bay and the smaller fjords and inlets along the more remote south shore. Homogeneous alongshore segments (10-100 meters in length) will be delineated and the physical component of the habitat characterized by up to ten geophysical parameters within each of three intertidal zones. These partitions include three intertidal polygons nested within each alongshore segment. Alongshore segments are grouped within oceanic cells to control for variations in salinity, temperature, nutrients and wave energy. These physical data provide the foundation to support comparisons and experimental studies of epibiota and infaunal abundances.

Methods Summary

1. At no cost to the project, use the existing and expanded system of ocean sensors at Homer and Seldovia, measuring salinity, temperature, D.O., pH, PAR, fluorescence and

turbidity to identify the spatial and temporal variability of ocean and estuarine water along and across the axis the Bay;

2. At no cost to the project, partner with the Cook Inlet Regional Citizens Advisory Council to obtain low altitude oblique aerial videography of the coastal zone in Kachemak Bay, at extreme low tides, for large scale (100-1,000 m) partitioning of the shoreline based on shore geomorphology, geophysical and biological characteristics of the nearshore, and characteristics of the upland watershed (Howes et al. 1994, Zacharias et al 1999);

3. Use *existing* NOAA high altitude vertical aerial photography and field measurements to map and partition the shoreline into geophysically homogeneous segments (10-100 m), quantifying the geophysical attributes known to force biological community structure in the nearshore marine system;

4. Build a GIS database of physical habitat features for intertidal and subtidal lands in Kachemak Bay and analyze the statistical distribution of characteristic habitat types.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Not applicable: all funds requested in this proposal will be used by ADFG/KBRR staff.

SCHEDULE

A Measurable Project Tasks

We intend to begin the fieldwork as soon as we are notified of a successful proposal. We anticipate 3 months of full-time field data collection, 2 months of data entry and analysis, and another 4 months of data analysis and GIS database development.

December 31, 2001:	complete fieldwork and begin data entry
February 28, 2002	complete data entry and begin GIS development
May 31, 2002	complete draft GIS database before summer field season
September 30, 2002	complete draft report
April 1, 2003	submit final report

B. Project Milestones and Endpoints

The project milestones are to complete a map the nearshore habitats in Kachemak Bay and quantify the physical attributes that force spatial variation in diversity of fish, invertebrate, and algal populations among characteristic habitat types in the Bay, will be met by the end of the funding period.

C. Completion Date

The work will be completed at the end of the funding cycle. The final report will be prepared by April 1, 2003. No funding is requested to complete this report.

PUBLICATIONS AND REPORTS

The product of this work is regarded as the foundation for further monitoring of the biological components of the ecosystem. The research and scientific value of this data is relevant to the monitoring of the biological components of the system; however, the management value will be realized immediately. As such, we do not expect to publish this data in a scientific journal until the biological data has also been collected and analyzed.

PROFESSIONAL CONFERENCES

The principal investigator is professionally obligated to present the results of Kachemak Bay research projects at the annual NERRS Research Conference (travel funded by NOAA), and the annual PISCO Conference (travel funded by PISCO). The PI seeks funding to attend the 2002 American Geophysical Union (AGU)/American Society of Limnology and Oceanography (ASLO) Conference.

NORMAL AGENCY MANAGEMENT

This project is <u>not</u> required by statute or regulation regardless of whether or not the spill had occurred. The proposed work has not been conducted by either ADFG or KBRR in the past without funds from the Trustees Council.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

We are coordinating this project with ADFG Commercial and Sport Fish Division projects in Kachemak Bay focusing on clam bed research, with the Cook Inlet RCAC to map beaches for oil spill response planning, with The Nature Conservancy to map important conservation areas, and with the City of Homer to map high use beaches for potential land use zoning (see attached letters of support).

The work proposed here will support the biological component of the study described in the accompanying Proposal (#02565): Bottom-up or Top Down: What Forces the Variability of Subtidal and Intertidal Fishes, Invertebrates and Algal Communities in Kachemak Bay?

Furthermore, we are building on the NOAA System Wide Monitoring Program by using the oceanographic time series data being collected in the Bay to identify and monitor the variability of major estuarine spatial and temporal divisions. The data collected will become a part of the PISCO database archived at the National Center for Ecological Analysis and Synthesis (NCEAS)

in Santa Barbara, CA.

We are partnering with the Cook Inlet Regional Citizens Advisory Council to map the shores of Kachemak Bay and parts of western Cook Inlet using an innovative technique of aerial mapping developed in British Columbia and Washington.

In summary, the KBRR has put forth a substantial effort to obtain funds from non-Council sources. KBRR proposals for EVOS Trustee funds will make it possible to secure additional NOAA funds to maintain and expand the Reserve system-wide monitoring program, which will be great benefit to the GEM program.

PROPOSED PRINCIPAL INVESTIGATOR

Dr. G. Carl Schoch
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PRINCIPAL INVESTIGATOR

Dr. Schoch is the Science Coordinator for the Kachemak Bay Research Reserve in Homer, Alaska (a NOAA National Estuarine Research Reserve). He has a dual Ph.D. in Biological Oceanography and Geological Oceanography from the College of Oceanic and Atmospheric Sciences at Oregon State University (1999) and continues to work with his post-doc advisors (Lubchenco and Menge) as a Senior Fellow for the Partnership for Interdisciplinary Studies of the Coastal Ocean (PISCO) studying marine ecosystem dynamics. His research interests are in the physical and biological linkages between marine nearshore and continental shelf ecosystems, specifically how physical processes such as currents, wave energy, sediment dynamics, and nutrient fluxes structure intertidal and subtidal communities. His current research projects include studying larval distributions and forces affecting recruitment, monitoring the variability of primary productivity as a function of ocean climate, and investigating kelp bed community dynamics. He serves as the science advisor for the Olympic Coast National Marine Sanctuary Advisory Council, and is the chair of their Research Advisory Committee. He also serves as the technical advisor to the Sanctuary Marine Conservation Working Group, consulting on the design and development of a marine reserve network on the outer coast of Washington. He also consults to the Washington Department of Natural Resources on intertidal habitat modeling in Puget Sound and Georgia Straits.

OTHER KEY PERSONNEL

The grant, if funded, will provide support for a Research Analyst, and a Research Assistant to assist with data entry and analysis. The NERRS Graduate Research Fellowship Program will provide 2 graduate students to assist Dr. Schoch with the fieldwork at no cost to the project.

LITERATURE CITED

Howes, D., J. Harper and E. Owens. 1994. British Columbia physical shore-zone mapping system. British Columbia Ministry of the Environment, Victoria.

Menge, B.A., B.A. Daley, P.A. Wheeler, and P.T Strub. 1997. Rocky intertidal oceanography: An association between community structure and nearshore phytoplankton concentration. *Limnology and Oceanography* 42(1): 57-66.

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Zacharias, M.A., M.C. Morris and D.E. Howes. 1999. Large scale characterization of intertidal communities using a predictive model. *Journal of Experimental Marine Biology and Ecology*. 239:223-242.

Revision 18-02
Approved TC 4-18-02

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel		$43.0
Travel		$2.0
Contractual		$6.0
Commodities		$4.3
Equipment		$0.0
Subtotal	$0.0	$55.3
General Administration		$6.9
Project Total	$0.0	$62.2
Full-time Equivalents (FTE)		0.8
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
Estimated FY 2003					
$20.0					

Dollar amounts are shown in thousands of dollars.

Comments: The KBRR went through a substantial effort to obtain funds and establish partnerships with other organizations to support the proposed research and monitoring effort. These efforts include:

NOAA/KBRR Support: The proposed EVOS projects (including proposals #02565 and #02569) will meet the required non-federal match for approximately $274K in NOAA operations funds. Federal funds will be used to operate and expand the Reserve monitoring program. These NOAA funds will support, in part, two research staff, the purchase of ocean sensors and a CTD, Reserve research and support facilities and equipment. Without this match, the KBRR will need to decline all or part of these funds, and likely will not be able to implement and maintain the long-term monitoring program.

Cook Inlet RCAC - The Cook Inlet RCAC will provide $30,000 for an aerial video survey of the bay to map geomorphogical processes

NERRS Graduate Research Fellows - KBRR is funding 2 graduate students ($34,000) who will assist with the summer field work and incorporate the data into their dissertation work.

FY02

Prepared: 4/12/01

Project Number: 02556
Project Title: Mapping the Physics and Physical Processes of Marine Habitats: the First Step in a Spatially Nested Monitoring Program
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2002
Steve Baird	GIS Specialist (Research Analyst II)	18A	3.0	4.0		12.0
(Hire in Progress)	Research Assistant (FB-I)	14A	4.0	4.0		16.0
						0.0
Dr. G. Carl Schoch	PI	18A	3.0	5.0		15.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		10.0	13.0	0.0	
					Personnel Total	$43.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2002
					0.0
Dr. G. Carl Schoch to attend GEM program development and planning work	0.2	2	8	0.2	2.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.0

FY02

Prepared: 4/12/01

Project Number: 02556
Project Title: Mapping the Physics and Physical Processes of Marine Habitats: the First Step in a Spatially Nested Monitoring Program
Agency: ADFG

FORM 3B
Personnel
& Travel
DETAIL

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:			Proposed FY 2002
Description			
Fuel for Skiff			6.0
When a non-trustee organization is used, the form 4A is required.		**Contractual Total**	$6.0

Commodities Costs:			Proposed FY 2002
Description			
Misc Supplies and Operating Expenses for Boat			1.5
Software upgrades	1	2.0	2.0
Surveyors rod	1	0.3	0.3
Surveyors level	1	0.4	0.4
Surveyors tape	1	0.1	0.1
		Commodities Total	$4.3

FY02

Prepared: 4/12/01

Project Number: 02556
Project Title: Mapping the Physics and Physical Processes of Marine Habitats: the First Step in a Spatially Nested Monitoring Program
Agency: ADFG

FORM 3B
Contractual & Commodities DETAIL

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2002
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Research Skiff	1	
KBRR headquarters and research facilities	2	
KBRR Computers	3	

FY02

Prepared: 4/12/01

Project Number: 02556
Project Title: Mapping the Physics and Physical Processes of Marine Habitats: the First Step in a Spatially Nested Monitoring Program
Agency: ADFG

FORM 3B
Equipment
DETAIL

Revised 11-5-01
Approved TC 12-11-01

Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound - Submitted Under the BAA

Project Number:	02574-BAA
Restoration Category:	Research and General Restoration
Proposer:	Dennis C. Lees, Littoral Ecological & Environmental Services
Lead Trustee Agency:	
Cooperating Agencies:	None
Alaska SeaLife Center:	No
Duration:	1st year, 2-year project
Cost FY 02:	$94,800
Cost FY 03:	$35,300
Geographic Area:	Prince William Sound
Injured Resource Services:	Clams, Intertidal Communities, Sediments, Sea Otters, Harlequin Ducks, Subsistence

ABSTRACT

Studies from 1989 through 1997 suggest that bivalve assemblages on beaches in PWS treated with high-pressure hot-water washing remain severely damaged in terms of species composition and function. This project will assess the generality of this apparent injury to these assemblages. A finding that our conclusions are accurate will indicate that a considerable proportion of mixed-soft beaches in treated areas of the sound remains extremely disturbed and that these beaches are functionally impaired in terms of their ability to support foraging by damaged nearshore vertebrate predators such as sea otters and harlequin ducks. The study will also provide insight into the need for remediation of beaches to restore biodiversity and function in these assemblages.

INTRODUCTION

The T/V *Exxon Valdez* ran aground in the northeastern part of Prince William Sound, Alaska, on March 24, 1989. Over the next several weeks, a substantial amount of the nearly 41 million liters of spilled Alaska North Slope crude oil was deposited on beaches in the southern and western portions of the sound and on Gulf of Alaska beaches to the southwest. Shoreline cleanup activities were carried out with varying degrees of intensity throughout the summer of 1989 on about 560 km (Harrison 1991) of the 780 km of oiled shoreline in the sound. A primary method of shoreline treatment in 1989 was hydraulic flushing with water heated to moderate to high temperatures (Lees et al. 1996).

In Prince William Sound, most of the oiled beaches were "cleaned," typically using high-pressure, hot-water washing techniques. The technique involved various methods of dislodging the oil by spraying the intertidal zone with heated sea water (40-60° C) and then skimming up the oil as it flowed down the beach and refloated on the tide. Commonly, the hot water was directed at the beach using hose nozzles or a large spray-head mounted on a mechanical arm.

Recent analyses of infaunal data from the NOAA study of treatment effects and recovery in intertidal sediments in the sound have suggested that infaunal assemblages remained fundamentally impaired as late as 1997. This impairment was most evident in bivalve assemblage but was generally apparent for most major infaunal taxa. While not always apparent from the perspective of overall abundance, the impairment is quite conspicuous from the perspective of species composition and biological function or trophic structure. For bivalves, it appears that larger burrowing suspension and deposit feeders that dominate at unoiled (reference) and oiled but untreated sites have been replaced at sites exposed to high-pressure hot-water (HP-HW) washing by smaller surficial suspension feeders. This means that valuable and preferred species that typically dominate at undisturbed beaches (e.g., the littleneck clam *Protothaca staminea*, and the butter clam *Saxidomus giganteus*, which are favored by sea otters, harlequin ducks, and subsistence gatherers, and various species of *Macoma*) are replaced by a small opportunistic species (i.e., *Hiatella arctica* and a tiny nestling clam *Rochefortia* (= *Mysella*) *tumida*. that are of little or no value to nearshore vertebrate predators. In addition to bivalves, this pattern was still apparent as late as 1997 for polychaetes, echinoderms, snails, and crustaceans. In fact, whole classes or families of invertebrates that dominated at reference and oiled but untreated beaches are lacking in the infauna at treated beaches. Moreover, our studies indicate that a return to the apparent climax assemblage is occurring very slowly, apparently from lack of recruitment by the more favored bivalves, and suggest that recovery is probably delayed by the slow rate of recovery in sediments, which were also seriously disturbed by the effects of HP-HW washing. The impaired condition of intertidal bivalve assemblages may be a contributing factor in the failure of sea otters and harlequin ducks to achieve significant recovery in some areas that were oiled and may be a critical issue in the restoration of those damaged resources. .

NEED FOR THE PROJECT

The primary reason we are proposing this study is that we became concerned about the implications of differences in condition of intertidal infaunal assemblages that we have observed

between oiled and treated, oiled but untreated, and unoiled reference sites in western Prince William Sound since 1989. We observed that the assemblages at the treated sites were substantially impoverished relative to those at the reference sites and that they displayed fundamental differences in functional capabilities. Moreover, we postulated that these differences were due primarily to differences in inorganic and organic sediment characteristics rather than hydrocarbons in the sediments.

As a consequence of these differences, the treated beaches that we observed were far less able to support foraging by organisms from higher trophic levels or to serve as subsistence harvest areas for the native or tourist populations in Prince William Sound. The impoverished condition of the bivalve assemblages may, in fact, be an important contributing factor in the failure of sea otters and harlequin ducks to demonstrate recovery in many oiled parts of the sound. Moreover, the increase in harlequin duck populations in other parts of the sound may be a consequence of movement to areas with more adequate food resources.

The geographic scope of our previous studies was, unfortunately, limited and cannot our findings cannot be extrapolated to the rest of the sound. Consequently, we are proposing this study to assess if the conditions that we observed in the intertidal infaunal assemblages and sediments occur generally in sediments on beaches exposed to high-pressure hot-water wash in western Prince William Sound. Determining the answer to that question could also provide helpful information in understanding the dynamics of sea otters and harlequin ducks in areas of the sound that were oiled and treated in 1989-90.

A. Statement of Problem

A large proportion of the mixed-soft sediment habitats in Prince William Sound was exposed to the spilled oil from the *Exxon Valdez* oil spill. Most of the oiled areas, however, were subsequently subjected to either warm- or hot-water washing. This process washed a considerable amount of the oil out of the area but mixed low concentrations of oil into the sediment column. Moreover, the process also flushed the finer sediment fractions and associated organic materials out of the sediment into the water column. Most of these materials were then carried away by the currents, leaving the sediments substantially altered in terms of particle grain size distribution and organic content. This process also flushed large numbers of the infaunal organisms out of the sediments and displaced or damaged them to a point where they were killed (Lees et al. 1996), leaving the infaunal assemblages greatly impoverished (Driskell et al. 1996).

A major objective of the infaunal study was to describe the differences in the structure of the infaunal assemblages existing among these treatment categories. This analysis focuses on the bivalve assemblages. The location of the various sampling sites is shown in Figure 1. Infaunal invertebrates were identified in sediment samples collected from oiled and treated, oiled but untreated, and unoiled (reference) intertidal sediments in Prince William Sound from 1989 through 1997. Invertebrate groups most commonly observed were, in decreasing order of abundance, Mollusca, Polychaeta, and Crustacea. Snails and clams were the most abundant mollusks.

Species composition and functional characteristics of intertidal infaunal assemblages at sites in Prince William Sound exposed to crude oil from the *Exxon Valdez* oil spill appear to have been influenced more by exposure to shoreline treatment than by exposure to oil. Dominance patterns of the infaunal invertebrates, which varied according to type of treatment, appear to provide

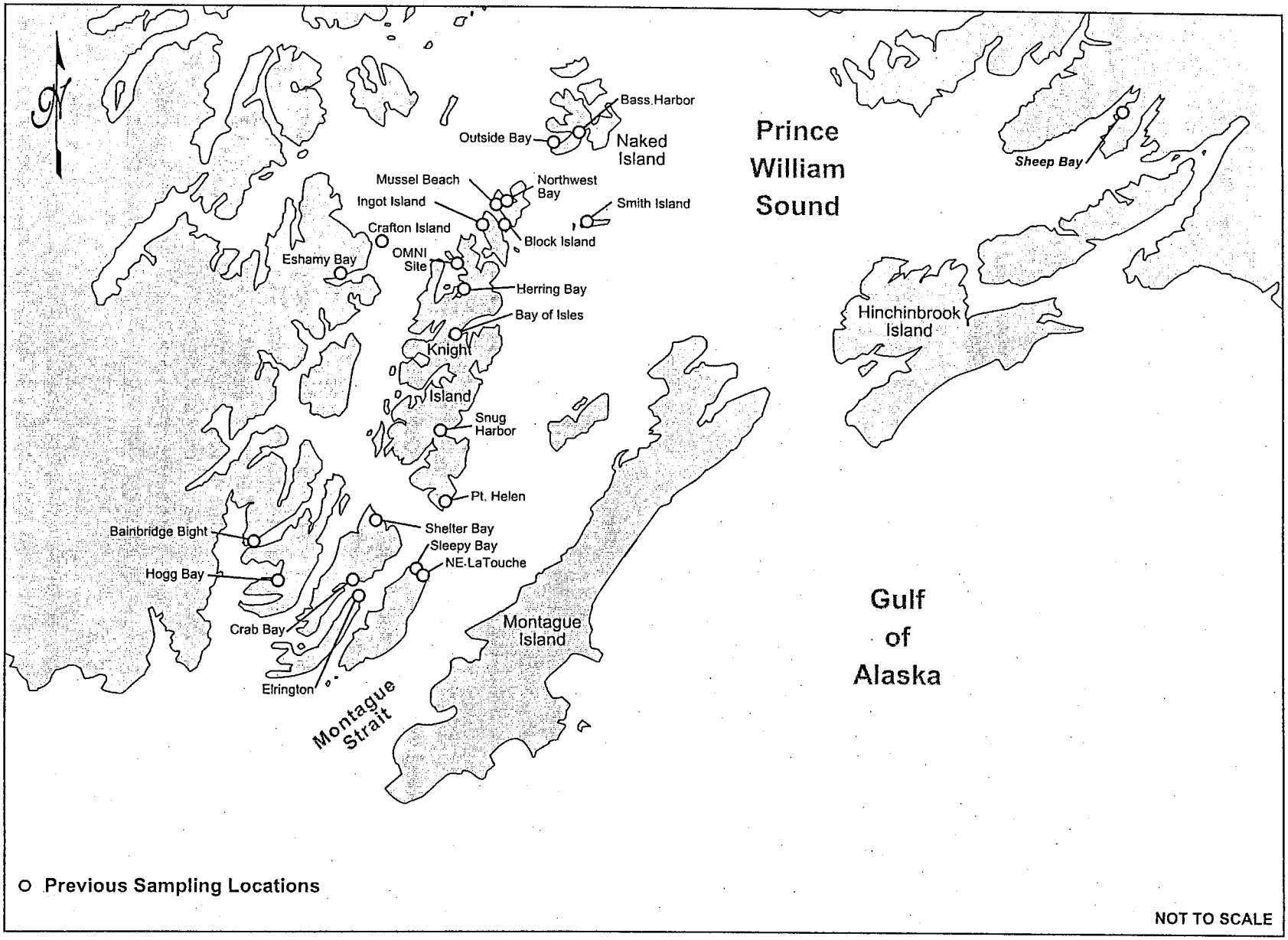


Figure 1. Prince William Sound study area and sampling locations in previous studies.

important insights into the effects of the spill, the ensuing treatment, and the recovery process. Life histories and ecological characteristics of the individual species suggest a rationale for the differences in dominance patterns seen among treatments. These patterns suggest that failure to achieve recovery is a consequence of lingering secondary effects from the spill rather than its primary effects.

These patterns are apparent in most of the major taxonomic groups that occur as infauna. For infaunal bivalves, lower values were typically observed at oiled and treated sites whereas highest numbers were observed at reference sites. Species richness, very similar at reference and oiled but untreated sites after 1990, declined slightly during the study. Abundance, also quite similar at reference and oiled but untreated sites, peaked in 1992 or 1993 and then gradually declined through the remaining years. In contrast, averages for species richness and abundance were substantially lower at oiled and treated sites and exhibited no apparent trends representing recovery (Figures 2a and 2b) . Differences in both variables were highly significant between reference and oiled but untreated sites, on one hand, and oiled and treated sites on the other. Similar patterns were observed in polychaetes, snails, and echinoderms. In contrast, these numerical characteristics were similar among the treatment categories for microcrustaceans.

Species richness and abundance of bivalves were significantly higher at reference and oiled but untreated sites than at oiled and treated sites, suggesting that community succession has reached a higher level at the former sites than at oiled and treated sites. All of the bivalve taxa observed were encountered at either reference or oiled but untreated sites whereas only eight taxa were observed at oiled and treated sites.

Dominance patterns and functional characteristics provide further important insights into the effects of the spill, shoreline treatment, and the recovery process. For bivalves, *Mysella tumida, Macoma* spp., and *Protothaca staminea* dominated at reference (unoiled) and oiled but untreated sites but they were far less common at oiled and treated sites. *Mysella* is typically commensal with larger burrowing species that were mostly absent or uncommon at oiled and treated sites. Although small, *Mysella* is relatively long-lived and reproduces slowly. In the absence of the burrowing hosts, it apparently nestles on the surface of the sediment. The other bivalve dominants generally are relatively long-lived, slowly reproducing species that bury up to several centimeters below the surface of stable sediments. In contrast, *Hiatella arctica*, the dominant bivalve at oiled and treated sites, is an opportunist that nestles on the surface of disturbed sediments or newly available substrate.

Species Composition

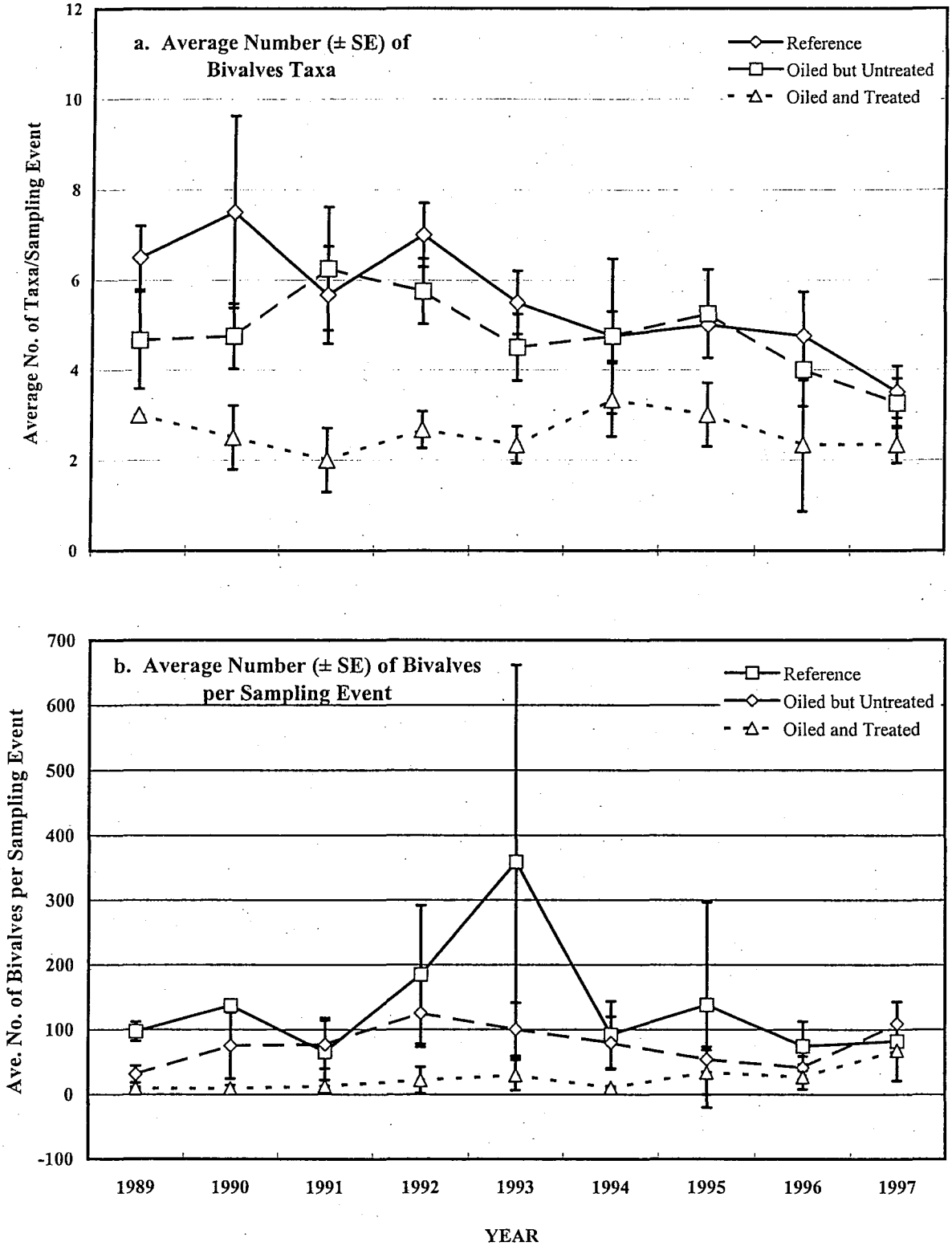
Bivalve assemblages observed in reference and oiled but untreated sites during this study were dominated by species of the bivalve families Montacutidae (a single species), Tellinidae, and Veneridae, both of the latter families represented by several taxa. Thus, reference and oiled but untreated sites have been dominated by relatively long-lived clams, mainly *Mysella tumida*, *Macoma* spp., and *Protothaca staminea* (Table 1). Most of these taxa characteristically burrow in stable sediments (e.g., *Macoma* and *Protothaca*; Peterson and Andre 1980; Houghton 1973; McGreer 1983). In contrast, members of the genus *Mysella* usually live in a commensal relationship in semi-permanent burrows with large burrowing infaunal organisms such as sea cucumbers, sipunculids, echiurans, or shrimp (Ockelmann and Muus 1978). In fact, abundance

Table 1

Dominance Patterns of Infaunal Bivalves in Treatment Categories

Taxon	Reference Sites			Oiled but Untreated Sites			Oiled and Treated Sites			Totals
	Total Number of Individuals	Percent Abundance in Category	Ave. No. per Sampling Event	Total Number of Individuals	Percent Abundance in Category	Ave. No. per Sampling Event	Total Number of Individuals	Percent Abundance in Category	Ave. No. per Sampling Event	
Clinocardium ciliatum	2	0.06	0.1							2
Compsomyax subdiaphana	2	0.06	0.1	3	0.1	0.1				5
Cryptomya californica	3	0.1	0.1							3
Diplodonta aleutica				19	0.7	0.5	2	0.3	0.1	21
Hiatella arctica	90	2.8	3.5	298	10.9	8.5	**460**	**71.0**	**18.4**	848
Macoma spp.	30	0.9	1.2	80	2.9	2.3	1	0.2	0.0	111
Macoma balthica	176	5.5	6.8	148	5.4	4.2	19	2.9	0.8	343
Macoma inquinata	295	9.2	11.3	299	10.9	8.5	1	0.2	0.0	595
Macoma obliqua	6	0.2	0.2	1	0.04	0.0				7
Mactridae, unid.				2	0.07	0.1				2
Mya arenaria	4	0.1	0.2	1	0.04	0.0				5
Mysella tumida	**2139**	**66.7**	**82.3**	**1327**	**48.5**	**37.9**	129	19.9	5.2	3595
Protothaca staminea	423	13.2	16.3	493	18.0	14.1	34	5.2	1.4	950
Saxidomus giganteus	33	1.0	1.3	58	2.1	1.7	2	0.3	0.1	93
Semele rubropicta				2	0.07	0.1				2
Tellina spp.	1	0.03	0.0							1
Tellina modesta	3	0.1	0.1	1	0.04	0.0				4
Tellinidae, unid.				5	0.2	0.1				5
Veneridae, unid.				1	0.04	0.0				1
Total Taxa in Category	14			16			8			
Total Individuals	3207			2738			648			6593
Ave. No./Sampling Event			123.3			78.2			25.9	76.7

Figure 2. Average Numbers of Bivalve Taxa and Individuals by Treatment Category



of *M. tumida* and two burrowing sea cucumbers, with which *Mysella* could have a commensal relationship, exhibited a significant positive correlation.

In contrast, oiled and treated sites were strongly dominated by a single species of the family Hiatellidae (Table 1). *Hiatella arctica*, an opportunistic, widely distributed "weed" species, nestles on the surface of disturbed sediments, on new rocks, or synthetic substrates (Morris et al. 1980; Gulliksen et al. 1980; MacGinitie 1955) and frequently dominates the biota in those habitats.

Temporal Changes of Dominant Taxa

Comparison of abundance patterns for the major species provides little evidence that dominance patterns have been changing in any of the treatment categories, especially at oiled and treated sites. In terms of raw abundance, none of the four species that dominated at reference or oiled but untreated sites showed any indication of significant increases at oiled and treated sites during the eight-year period following EVOS (Figures 3 through 6). In contrast, *Hiatella arctica* remained consistently the dominant species at oiled and treated sites (Figure 7, Table 2). When viewed in terms of relative abundance to reduce the influence of variation in overall abundance, it is still clear that dominance relationships at oiled and treated sites were not changing to any great extent (Table 2).

Mysella tumida

This small long-lived suspension-feeding clam lives near the surface of the sediment or in burrows of burrowing forms such as sea cucumbers, sipunculids, echiurids, or shrimp (Ockelmann and Muus 1978). It was by far the most abundant species at reference and oiled but untreated sites, comprising 66 and 43 percent, respectively, of the total bivalves collected in sites from these categories. Nevertheless, the average number of *Mysella* per sampling event (94.2 individuals) was nearly three times higher in reference sites than at oiled but untreated sites (35.2 individuals; Table 1). *Mysella* was particularly abundant at Outside Bay (Figure 3). The species was twice as abundant as *Protothaca staminea*, the next most abundant species in both categories. In contrast, overall abundance of *Mysella*, comprising only 28 percent of the total number of bivalves at oiled and treated sites, was an order of magnitude less abundant in this category. The average number of *Mysella* per sampling event in oiled and treated sites were an order of magnitude lower than in reference and oiled but untreated sites (Table 1).

Protothaca staminea

The little-neck clam *Protothaca staminea*, a suspension feeder (Morris et al. 1980; Peterson and Andre 1980), burrows to moderate depths. It probably lives at least 10 years. It was the second most abundant bivalve at reference and oiled but untreated sites, comprising 13 and 19 percent, respectively, of the total bivalves collected in these categories. The average number of *Protothaca* per sampling event, averaging 18.7 and 15.8 individuals per sampling event, respectively, was nearly the same in both categories (Table 1). It was relatively quite abundant at Outside and Sheep Bays, Block Island, and Mussel Beach South but an order of magnitude less abundant at the remaining reference, oiled but untreated, and oiled and treated sites (Figure 4). Although the abundance of *Protothaca* was patchy among reference and oiled but untreated sites, it was consistently sparse at oiled and treated sites, where density was about one-tenth that

Figure 3
Trends in Numbers of *Mysella tumida* at Variously Treated Sites in Prince William Sound in Years Following EVOS

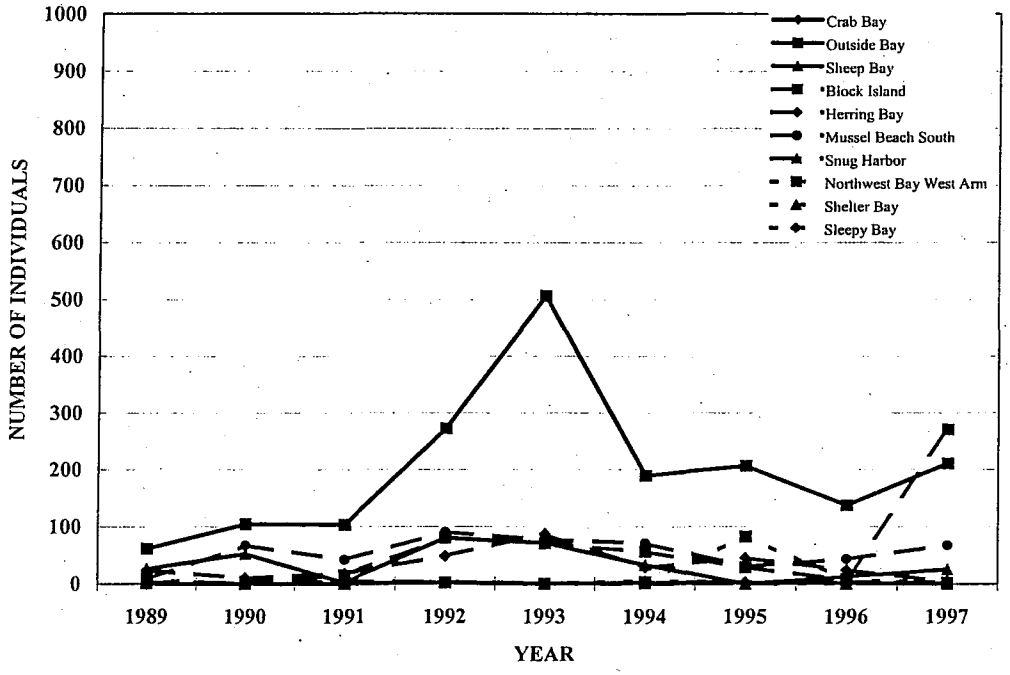


Figure 4
Trends in Numbers of *Protothaca staminea* at Variously Treated Sites in Prince William Sound in Years Following EVOS

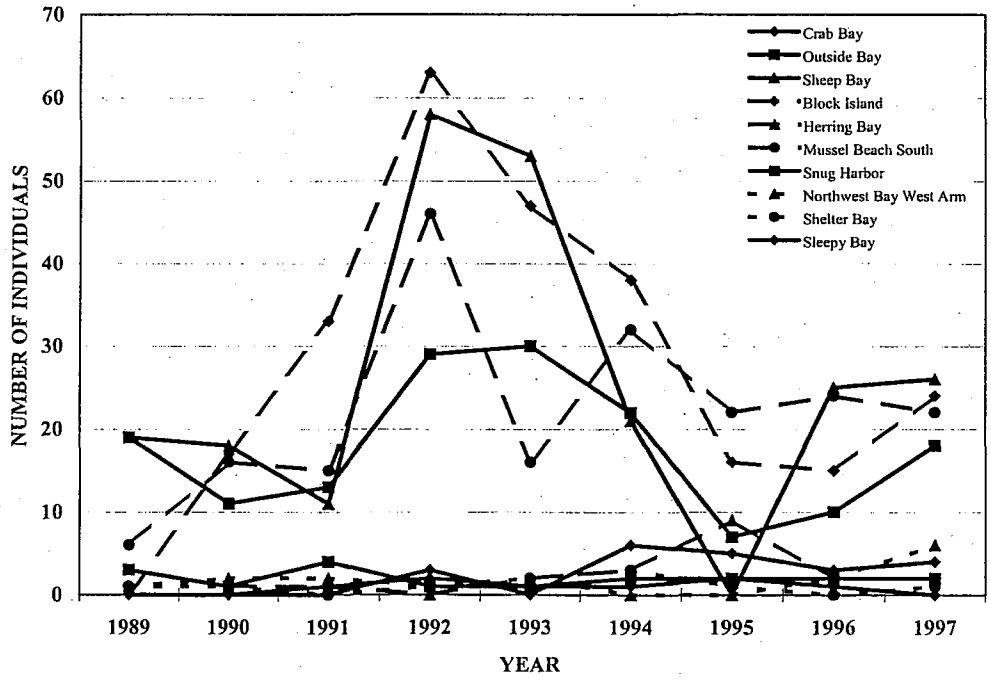


Figure 5
Trends in Average Numbers of *Macoma inquinata* at Variously Treated Sites in Prince William Sound in Years Following EVOS

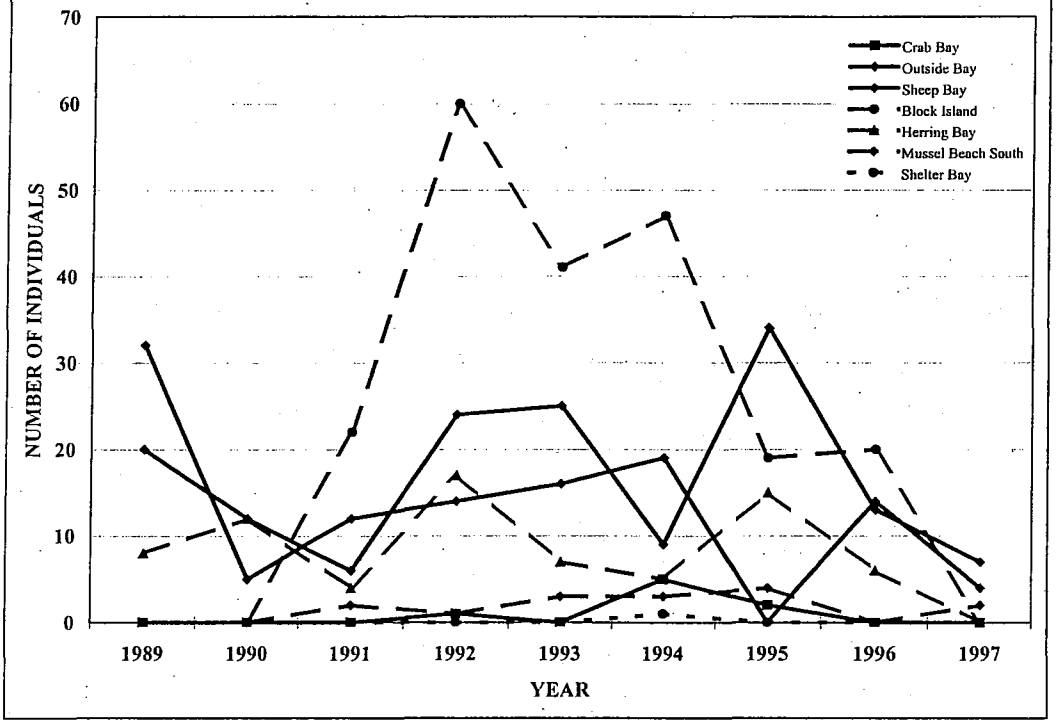


Figure 6
Trends in Numbers of *Macoma balthica* at Variously Treated Sites in Prince William Sound in Years Following EVOS

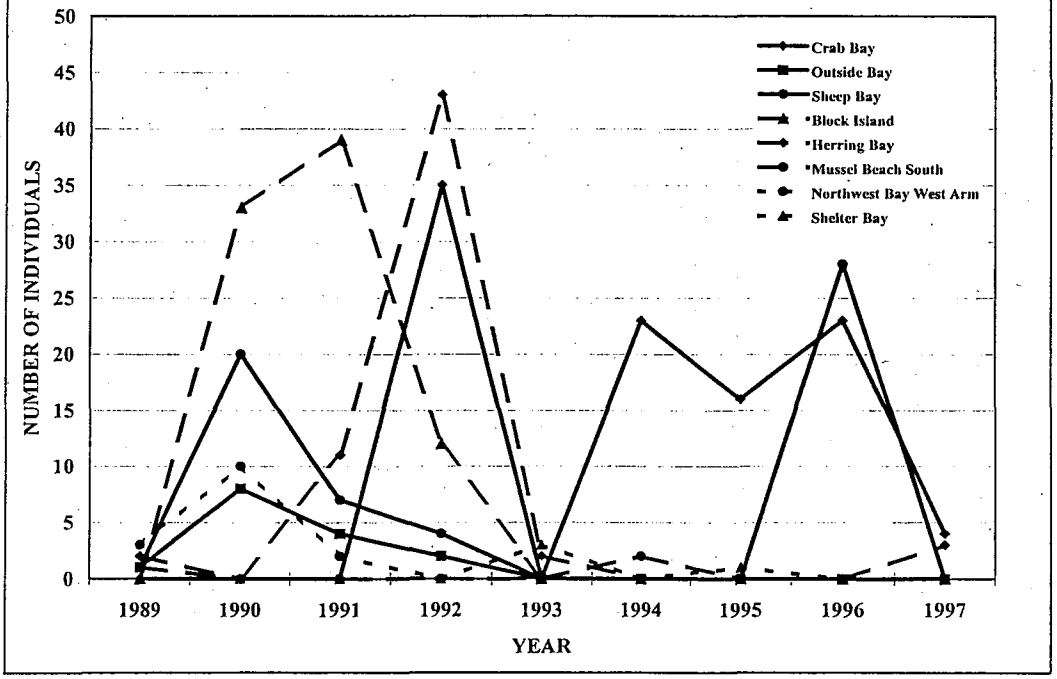


Table 2

Temporal Patterns in Relative Abundance of Infaunal Bivalves
Relative to Treatment Category

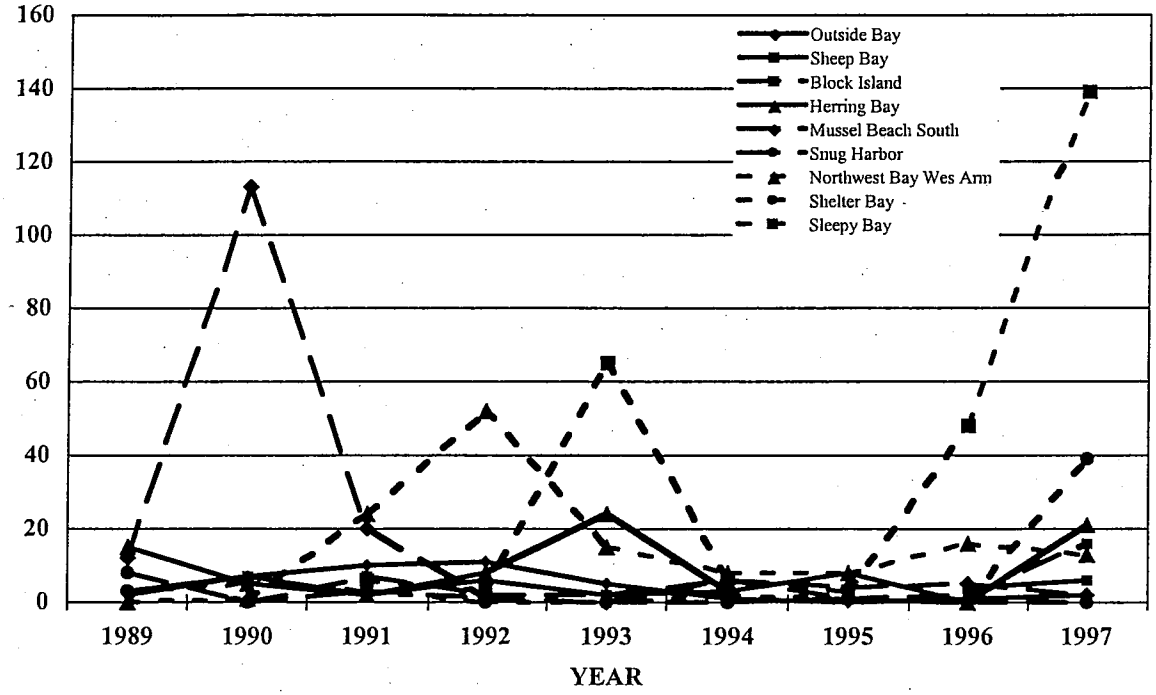
Percent of Total Abundance in Category by Year

Category/Taxon	1989	1990	1991	1992	1993	1994	1995	1996	1997	Average	Std. Error
Reference Sites											
Hiatella arctica	2.6	5.1	7.7	3.2	1.0	1.9	0.0	4.0	3.7	3.2	0.81
Macoma balthica	1.0	10.2	5.6	7.4	0.0	6.3	5.8	17.1	1.2	6.1	1.88
Macoma inquinata	26.7	6.2	11.7	7.0	5.7	10.6	13.0	10.7	4.9	10.7	2.35
Mysella tumida	44.6	56.9	58.7	63.9	80.4	65.2	75.4	52.0	75.3	63.6	4.19
Protothaca staminea	19.5	10.6	12.8	16.2	11.6	14.7	4.3	14.4	14.9	13.2	1.50
Saxidomus giganteus	5.1	1.8	1.0	0.7	0.7	1.1	0.4	0.7	0.0	1.3	0.54
Total Individuals by Year	195	274	196	554	718	368	276	298	328	356.3	61.13
Ave. No./Sampling Event*	97.5	137.0	65.3	184.7	359.0	92.0	138.0	74.5	82.0	136.7	
Oiled but Untreated Sites											
Hiatella arctica	37.2	39.2	10.4	2.4	6.5	4.7	6.5	4.2	8.9	13.3	5.06
Macoma balthica	3.2	11.0	16.2	11.0	0.5	0.6	0.0	0.0	0.7	4.8	2.20
Macoma inquinata	8.5	4.0	9.1	15.6	12.7	17.4	18.1	15.8	0.5	11.3	2.19
Mysella tumida	35.1	26.9	25.6	44.2	58.6	48.9	47.7	47.3	78.4	45.9	5.76
Protothaca staminea	12.8	11.6	17.2	22.0	16.5	23.7	22.7	26.1	11.5	18.2	1.97
Saxidomus giganteus	1.1	2.0	2.6	1.4	2.0	0.3	0.9	2.4	0.0	1.4	0.32
Total Individuals by Year	94	301	308	500	401	317	216	165	436	304.2	46.20
Ave. No./Sampling Event*	31.3	75.3	77.0	125.0	100.3	79.3	54.0	41.3	109.0	76.9	
Oiled and Treated Sites											
Hiatella arctica	15.8	31.6	86.8	83.3	89.9	51.6	11.8	79.0	94.1	60.4	11.75
Macoma balthica	15.8	52.6	5.3	0.0	3.4	0.0	1.0	0.0	0.0	8.7	6.10
Macoma inquinata	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0	0.4	0.38
Mysella tumida	57.9	0.0	0.0	10.6	0.0	29.0	83.3	14.8	2.5	22.0	10.54
Protothaca staminea	10.5	15.8	7.9	6.1	5.6	12.9	2.9	3.7	3.4	7.7	1.60
Saxidomus giganteus	0.0	0.0	0.0	0.0	1.1	3.2	0.0	0.0	0.0	0.5	0.39
Total Individuals by Year	19	19	38	66	89	31	102	81	203	72.0	20.51
Ave. No./Sampling Event*	9.5	9.5	12.7	22.0	29.7	10.3	34.0	27.0	67.7	24.7	

* Number includes taxa not included in this summary table

of *Hiatella* (Table 1). Also, with an average of 1.4 individuals per sampling event, it was about an order of magnitude less abundant in oiled and treated than at reference and oiled but untreated sites (Table 1).

Figure 7
Trends in Numbers of *Hiatella arctica* at Variously Treated Sites in Prince William Sound in Years Following EVOS



At the four sites at which *Protothaca* was more abundant (noted above), its abundance peaked in 1992 and 1993 (Figure 4) and then appeared to decline in the following years. Nevertheless, the abundance of *Protothaca* appeared to remain at a higher level at these stations than at the other stations both before and after this period of peak abundance. It was consistently second or third most abundant at reference and oiled but untreated sites.

Macoma inquinata

This long-lived deposit-feeding clam, likely the deepest burrower of the more abundant bivalve species considered in this discussion, probably lives more than 5 years. It was the third most abundant clam at reference and oiled but untreated sites, comprising 9.5 and 12.9 percent, respectively, of the total bivalves collected in sites from these categories. The average number of individuals per sampling event was also basically the same (13.7 versus 10.6 individuals per event). *Macoma inquinata* was particularly abundant at Outside, Sheep, and Herring Bays and Block Island (Figure 5). Shelter Bay was the only oiled and treated site at which this species occurred.

Macoma balthica

This deposit-feeding clam (Newell 1965: Taghon 1982) burrows to shallow or moderate depths and can live at least five years (McGreer 1983). The average number of *Macoma balthica* per

sampling event ranged from 9.1 at reference sites to 1.0 at oiled and treated sites. This shallow-burrowing clam was most abundant at Block Island and Crab, Herring, and Sheep Bays. It was not observed at either Snug Harbor or Sleepy Bay (Figure 6). It was relatively uncommon in 1989, increased considerably at several stations in 1990 through 1992, and then declined dramatically at most stations from 1993 through 1996 (Figure 6).

Hiatella arctica

This suspension-feeding clam nestles in crevices on rocks at the surface of the substrate (Gulliksen et al. 1980). It was the third most abundant bivalve observed in the infaunal samples. It was the most abundant bivalve at oiled and treated sites, where it was twice as abundant as *Mysella tumida*, the next most abundant bivalve at oiled and treated sites (Table 1; 13.5 versus 6.2 individuals per sampling event). However, it only ranked fourth or fifth in the other categories.

Based on temporal abundance patterns observed in this study, it probably lives less than 3 years. *Hiatella* apparently failed to establish persistent populations wherever it appeared, instead exhibiting one- or two-year pulses at sites when it appeared (Figure 7). Even at oiled and treated sites, *Hiatella* only dominated the bivalve assemblage in 1991 through 1994 and in 1996.

Patterns in Sediment Characteristics

Several physical and chemical characteristics of sediments that can influence development of infaunal assemblages include particle grain size (PGS), total organic carbon (TOC), total Kjeldahl nitrogen (TKN), and polycyclic aromatic hydrocarbons (PAH) were measured.

Generally, sediments at all sampling sites were relatively coarse and most contained substantial quantities of pebbles. Average median grain size was finest at reference sites, where PGS averaged 1.9 mm, and coarsest at oiled but untreated sites, where PGS averaged >5.8 mm. Concentrations of fines in the sediments were generally low, ranging from 21.4 percent at reference sites to 5.0 percent at oiled and treated sites (Table 3).

In addition to fine particulates, sediments at reference and oiled but untreated sites were characterized by higher concentrations of total organic carbon (TOC) and total Kjeldahl nitrogen (TKN) than oiled and treated sites (Table 3). Highest concentrations of organics were measured at oiled but untreated sites and lowest at oiled and treated sites. This condition is probably partially related to whether or not the specific beaches experienced beach washing. These differences are significant except for the comparison of TOC between the reference and oiled and treated sites, percent fines between the reference and oiled but untreated sites, and PGS between reference and oiled and treated sites. The significant differences between reference and oiled but untreated sites in TOC and TKN are probably related to the oil residuals in the sediments and the bacterial flora operating to metabolize the oil.

Comparison of carbon:nitrogen (C:N) ratios provides further insight into the sediment quality at these sites. C:N ratios at reference and oiled but untreated sites are about 50 percent lower than at oiled and treated sites. This indicates that, per unit of carbon, nitrogen concentrations (largely contributed by bacteria on particulates) are lower at oiled and treated sites than elsewhere. This suggests that nutrient quality is poorer for deposit feeders (and selected suspension feeders) at oiled and treated sites than at reference or oiled but untreated sites (e.g., Newell 1965).

Table 3

Comparison of Sediment Characteristics at Infaunal Stations

Category/Site	Elevation Relative to MLLW (feet)	Median Grain Size (mm)	% Fines	PAH (ng/g)	TOC (%)	TKN (%)	C:N Ratio
Reference							
Bainbridge Bight	1.3	2.4	21.5	0.6	1.7	0.041	42.5
Crab Bay	–	1.5	18.6	5.4	2.4	0.047	49.8
Outside Bay	0.3	2.4	20.6	1.4	1.3	0.032	42.1
Sheep Bay	1.3	1.2	24.9	1.4	1.2	0.043	26.5
Average	1.0	1.9	21.4	2.7	1.6	0.041	40.2
Std. Error	0.3	0.4	1.5	0.8	0.3	0.004	5.7
Oiled but Untreated							
Block Island	3.6	2.8	14.6	2547	1.9	0.041	45.7
Herring Bay	-0.1	1.9	24.4	18	1.5	0.040	38.3
Mussel Beach South	-0.7	5.8	9.0	47	2.9	0.079	37.0
Snug Harbor	-0.4	>12.5	14.1	220	3.8	0.196	19.2
Average	0.6	>5.8	15.5	807	2.5	0.089	35.1
Std. Error	1.2	>2.8	3.7	431	0.6	0.043	6.5
Oiled and Treated							
Northwest Bay West Arm	0.5	3.9	3.4	19	0.8	0.009	88.1
Shelter Bay	0.5	3.1	7.2	67	0.8	0.013	57.9
Sleepy Bay	-0.8	3.9	4.2	77	1.9	0.025	76.0
Average	0.1	3.6	5.0	54	1.2	0.016	74.0
Std. Error	0.4	0.3	1.2	17	0.4	0.005	8.8

Because of the remoteness of these beaches from substantial sources of fine particulates, it is likely that the recovery to pre-treatment grain-size distributions could require at least several decades (pers. comm., Dr. M. O. Hayes). All of these beaches are relatively protected from wave action so the coarseness of the sediments on the beaches not exposed to washing is a strong indication that deposition rates are very slow. Although a strong relationship is frequently observed between fine particulates and organics (e.g., Newell 1965; Hartman 1965), it was not apparent is these data. However, as Cammen (1982) reported, neither TOC nor TKN exhibited an appreciable relationship to percent fines.

Average concentrations of PAH in sediments were lowest at reference sites sand highest at oiled but untreated sites and differed substantially among the three categories. Nevertheless, PAH concentrations at oiled but untreated sites (Table 3) are three to four orders of magnitude below concentrations used by Pearson et al. (1981) to assess effects of crab predation on *Protothaca* due to behavioral changes following exposure to oiled sediments. They are also below concentrations reported by Bernem (1982) as not causing mortality in *M. balthica*. The NOAA ER-L for PAH is 4022 ppb (Long et al. 1995), almost two times that of the highest average observed. Furthermore, PAH concentrations at both oiled but untreated and oiled and treated sites were declining by about 25 percent per year.

Possible Factors Influencing Composition Differences

The biological characteristics of the bivalve assemblages differed considerably among the treatment categories (Table 4). Reference and oiled but untreated sites supported relatively diverse robust populations of both suspension and deposit feeders and burrowing species appeared to thrive. In contrast, the relatively impoverished bivalve assemblages at oiled and treated sites were strongly dominated by suspension feeders, especially *Hiatella*, that live mainly at the surface of the sediments (Tables 1 and 4). Abundance of deposit feeders and burrowing species was low. Notably, *Hiatella* was substantially more abundant at oiled but untreated sites than at reference sites.

It is likely that several physicochemical and ecological factors are combining to cause the observed differences in community structure. Possibly physicochemical factors influencing larval recruitment and growth and survival of suspension- and deposit-feeding bivalves at oiled and treated sites include: 1) reduced fines, 2) nutrient concentrations, and 3) nutrient quality. Larvae for the species that dominate at the reference and oiled but untreated sites are more likely to settle out (recruit) in sediments with higher rather than lower concentrations of fine particulates or organics (TOC and/or TKN; e.g., Ockelmann and Muus 1978; Thorson 1957). In fact, except for *Hiatella*, significant recruitment events were lacking at oiled and treated sites (Figure 7). In contrast, they were commonly observed at most reference and oiled but untreated sites for all other dominant bivalve species (Figures 3 through 6).

Deposit feeders require large quantities of fines in order to survive and support growth (Lopez and Levinton 1987). Taghon (1982) reported than many deposit feeders effectively select smaller particles with a protein coating. Based on concentrations of carbon, nitrogen, and the C:N ratio (Table 3), nutrition conditions are considerably more favorable for suspension and deposit feeders at reference and oiled but untreated sites than at oiled and treated sites.

Table 4

Comparison of Relevant Biological Characteristics of Dominant Bivalve Species

Characteristic	Clam Species				
	Mysella tumida	*Protothaca staminea*	*Macoma inquinata*	*Macoma balthica*	*Hiatella arctica*
Potential Longevity (Years)	Up to 7	> 10	> 5	> 5	< 3?
Feeding Type	Suspension	Suspension	Deposit	Deposit	Suspension
Common Burrowing Depth (cm)	Surficial or nestles in host burrows	5 to 8	5 to 15	1 to 15	Nestles on surface of substrate
Dominance Pattern	All Types of Sites	Reference and Oiled but Untreated Sites	Reference and Oiled but Untreated Sites	Reference and Oiled but Untreated Sites	Oiled and Treated

Potentially relevant ecological factors include: 1) the paucity of host species to support *Mysella*, 2) paucity of adult populations to stimulate recruitment, 3) decreased predation on *Hiatella* at oiled but untreated and oiled and treated sites, and 4) predation and/or interference exclusion of the other bivalves by *Hiatella* at oiled and treated sites. The paucity of potential hosts at oiled and treated sites probably accounts in part for the failure of *Mysella* to recolonize these recently disturbed areas. Burrowing organisms such as sea cucumbers, sipunculids, echiurans, and shrimp were considerably less abundant at oiled and treated sites than at reference or oiled but untreated sites (Houghton et al. 1997). Moreover, the presence of adult infaunal organisms has been shown to facilitate recolonization of depauperate sediments (Thrush 1992), but these forms were generally lacking at these sites. Gulliksen et al. (1980) observed that *Hiatella* became dominant in areas with reduced predation. It is possible that the increased density observed for *Hiatella* at oiled but untreated and oiled and treated sites is a consequence of losses of predators following exposure to crude oil and, at oiled and treated sites, shoreline cleaning activities.

Recovery Predictions

Based on apparent patterns in community structure and sediment characteristics, habitats in greatest need of recovery are sites that were treated similarly to oiled and treated sites, i.e., washed with high pressure hot water. None of the sediment characteristics except PAH appeared to exhibit temporal patterns indicating recovery by 1996. PAH concentrations, however,

generally decreased, on average, 25 percent annually at oiled but untreated and oiled and treated sites between 1990 and 1993.

Based on the apparent lack of recruitment in the dominant bivalve species, it is likely that recovery of the bivalve assemblages at the oiled and treated sites will be delayed for a long period of time. Recovery seems to be tied more to re-establishment of initial sediment conditions and community structure disturbed by the shoreline treatment program than to reductions of PAH concentrations.

Conclusions

1. Bivalve assemblages at reference and oiled but untreated sites had significantly higher numbers of species and individuals than those at oiled and treated sites.

2. Species composition and dominance patterns at reference and oiled but untreated sites were very similar but differed markedly from those at oiled and treated sites.

3. Thus, it appears that exposure to oil, by itself, did not result in a significant long-term influence on infaunal bivalve assemblages in intertidal sediments in Prince William Sound.

4. However, it appears that exposure to shoreline treatment aimed at removing oil from the intertidal zone was accompanied by significant long-term impacts to infaunal bivalve assemblages. These impacts are partly a consequence of disruptions to the assemblages existing at the sites prior to the oil spill and to significant alterations of sediment conditions at the sites.

5. Because of the distance from these areas to regions producing substantial quantities of fine particulates, recovery of the sediment structure may take several decades.

6. Because recovery is based on, at least, re-establishment of: 1) complex interspecific interactions in the infaunal assemblages; and 2) sediment conditions, it is likely that recovery of the bivalve (and, concurrently, other components of the infaunal) assemblages in the intertidal zone at treated sites will require many generations of the invertebrate species before it is complete.

B. Rationale/Link to Restoration

What is described above is what we have found for a limited number of sites. At this point, no other studies have been continued long enough to observe the conditions that concern us and these conditions have not been reported elsewhere. Consequently, no other studies have suggested that sediment conditions such as reduced concentrations of fine particles, reduced availability of organic debris, or depressed microbial biomass, may be limiting the nature and rate of recovery of the intertidal infaunal assemblage. However, the implications of these conditions are momentous in terms of the ability of treated beaches to support foraging by higher trophic levels, especially nearshore vertebrate predators such as sea otters or harlequin ducks, and in terms of recovery rates,. We believe they are potentially significant and they need to be investigated to ensure the sound becomes whole again in less than geologic time.

This program is linked closely to the Nearshore Vertebrate Predator program. Personal observations and photographs from western Prince William Sound indicated that sea otters and sea ducks foraged intensively in intertidal areas before the spill. However, sea otters populations are not recovering in bays on northern Knight Island (pg 17, FY 02 Invitation). Harlequin ducks are also not recovering in parts of the sound that were oiled. Inadequate clam resources could be one contributing factor in these recovery failures. However, this has not been investigated satisfactorily for intertidal habitats and may be a critical issue in the restoration of these other damaged resources.

This program provides an important linkage between the basic impact study that was designed to assess the nature of impacts and the rate of recovery, on one hand, and restoration efforts, on the other. Our initial studies have suggested the potential nature of the impacts in infaunal assemblages and have suggested mechanisms that could be responsible for the observed impacts. This program will provide insight into the generality and extent of the reported impact. Moreover, it will provide a detailed examination of some of mechanisms that could be driving the observed impact and could be the key to a restoration effort.

Within the framework of the goals of the Gulf Ecosystem Monitoring (GEM) program planned by the EVOS Trustee Council, this program would address Shorter-term Focused Research (i.e., the lingering effects of EVOS discussed on pg 29 of the GEM Review Draft, March 7, 2000) and long-term monitoring. It would provide insights into whether general restoration projects should be carried out on mixed-soft substrates in order to bring about recovery of intertidal bivalve and other infaunal resources important to nearshore vertebrate predators and human subsistence fishing.

In terms of the long-term monitoring aspects of the planned GEM program, this program can be viewed as a first step for establishing long-term monitoring of intertidal bivalve resources in the region. It would establish a network of sampling sites in Prince William Sound that could be expanded into the Gulf of Alaska (Blying Sound and the Outer Kenai Peninsula), Cook Inlet, and onto Kodiak Island, as discussed on pg 79 of the draft document.

C. Location

Prince William Sound is a protected fjord system located on the southcentral coast of Alaska (Figure 1). The shoreline is heavily dissected and irregular, providing a high diversity of shoreline types and a wide range of exposure. We are proposing to conduct these studies in central, western, and southwestern portions of Prince William Sound, which lay in the path of the oil slick as it flowed through the sound. Areas where sites may be selected include: the Naked Islands, Perry Island, islands in the Knight Island archipelago (i.e., Knight, Eleanor, and Disk Islands, and the smaller islands on the west side of Knight Island), Chenega, Bainbridge, Evans, Elrington, Latouche, and Green Islands, and the mainland bordering the west side of the sound from Port Nellie Juan to Port Bainbridge.

Many beaches on the islands and mainland in this area were oiled. We propose to focus on areas that were moderately to heavily oiled and subsequently exposed to shoreline treatment involving high-pressure hot-water washing. We propose to concentrate our efforts on beaches in protected embayments and small coves that are primarily composed of a mixture of gravel, sand, and silt (mixed-soft). However, we will also sample in relatively more exposed beaches such as Sleepy

Bay. We also propose to intersperse reference (unoiled and untreated) sites throughout the sampling area to the degree possible.

The semi-diurnal tides have an extreme tidal excursion of about 5.5 m. We propose to sample the beaches between Mean Lower Low Water (MLLW = 0 meter) and 0.8 m above MLLW. While the treated sites that we examined during the NOAA study ranged from –0.25 m to +0.15 m relative to MLLW, we are aware that shoreline cleanup crews attempted to avoid washing the lower intertidal. Therefore, we are proposing to sample at a higher level to increase the likelihood of sampling at elevations that were treated. Densities of the littleneck clam and other species were common within or above this elevation range at most of the untreated or reference sites sampled during our NOAA studies. In contrast, infaunal assemblages were impoverished at sites above +1.3 m.

Prince William Sound was recently subjected to another catastrophic event when it was uplifted by the 1964 Good Friday Earthquake. The portion of the sound in which our studies will be conducted was uplifted from ~4 feet in the vicinity of the western mainland and islands to ~10 feet on Latouche Island (Hanna 1971). Heaviest oiling occurred in areas that were uplifted from 4 to 8 feet.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

We propose to include a community involvement element for the regional native villages in this program. The purposes of this element are to: 1) disseminate the findings of our previous studies to the natives; 2) describe the objectives of the proposed study; and 3) solicit traditional knowledge from the natives regarding locations of beaches traditionally used for gathering clams. To accomplish the goals of this element, we propose to involve natives from New Chenega, Tatitlek, and possibly Valdez. We propose to contact the native communities by telephone and mail initially and, subsequently, conduct informal meetings in each location if this is deemed desirable. These meetings will be organized with the assistance of Ms. Sarah Ward, the Spill Area-Wide Coordinator for the Trustee Council and Dr. Henry Huntington, the Traditional Ecological Knowledge Specialist for the Council. In mailings, we will describe the findings of our previous studies, our conclusions, and their implications for recovery and restoration of bivalve assemblages on the affected beaches in the sound. We will describe our plans for this program, i.e., where we are going, and what we are trying to achieve. In order to identify historically productive beaches, we will solicit information from the native elders to identify traditional subsistence gathering beaches in and adjacent to the region exposed to the oil spill.

If deemed desirable, we will meet with native groups during our field studies to expand on the information that we have provided. At each meeting, we will make an informal presentation with slides and maps describing our findings.

PROJECT DESIGN

A. Objectives

The purposes of this program are to determine if the impoverished condition of intertidal bivalve assemblages observed in oiled and treated areas during the NOAA 1990-97 studies is general to treated sites throughout the western sound and to examine the sediment characteristics that may be causing it. The program will address two major objectives. The first is to evaluate whether the depressed condition of bivalve assemblages at treated sites observed in our earlier work is general to treated sites throughout western Prince William Sound. The second objective is to evaluate the role that three sediment characteristics may play in the apparent depression of bivalve assemblages in treated sediments. The four major hypotheses that will be tested to compare patterns in bivalve assemblages between oiled and treated and reference sites in western Prince William Sound are listed below:

Bivalve Assemblages

1. H_0 = Numerical characteristics of the bivalve assemblage (numbers of taxa and individuals) are similar at treated and reference sites.

   H_a = Numerical characteristics of the bivalve assemblage exhibit lower values at treated sites that at reference sites.

A. H_0 =Species composition of the bivalve fauna is similar at treated and reference sites.

   H_a = Species composition of the bivalve fauna is more complex and productive at reference sites than at treated sites.

3. H_0 = Functional characteristics of the bivalve assemblage (dominance by deposit feeders, tubicolous or burrowing forms) are statistically similar at treated and reference sites. Deposit feeders and tubicolous or burrowing forms are equally abundant at treated and reference sites.

   H_a = Functional characteristics of the bivalve assemblage are dissimilar at treated and reference sites. Deposit feeders and tubicolous or burrowing forms are more abundant at reference sites than at treated sites.

Sediment Characteristics

4. H_0 = Sediment characteristics are statistically similar at treated and reference sites. Percent silt/clay, Total Organic Carbon, Total Kjeldahl Nitrogen, , and C:N ratios are similar at treated and reference sites.

   H_a = Sediment characteristics are dissimilar at treated and reference sites. Total Percent silt/clay, Organic Carbon, and Total Kjeldahl Nitrogen are lower at treated than at reference sites., and C:N ratios are higher at treated than at reference sites.

B. Methods

Approach

The approach we are proposing addresses whether the depressed condition of bivalve assemblages observed at treated sites in our earlier work is generally occurring at treated sites throughout western Prince William Sound. It examines species composition and ecological function for the intertidal bivalve assemblages. This study will involve 22 sites throughout western Prince William Sound that were oiled and subsequently treated with high-pressure hot-water wash techniques and 12 reference sites that have not been oiled or treated but are otherwise similar. For this study, we will focus on bivalves. We will also characterize several relevant sediment characteristics at all sampling sites.

Sampling Design

Based on the results of power analyses (see below), we propose to sample at 22 oiled and treated sites and 12 reference sites. We will collect five replicate samples for bivalves and sediment grain size at each of these sites. Samples for important sediment characteristics such as particle grain size, total organic carbon, and total Kjeldahl nitrogen will be collected for each replicate and composited for each site.

Random Selection of Sites

A large proportion of the sites will be selected in a stratified random manner in order to reduce the potential variability that could be experienced if all beaches were considered together. The region will be stratified geographically into northern and southern strata. The east-west oriented portion of Knight Island Passage will act as the dividing line between the southern and northern strata. Each of these strata will be further stratified on the basis of oiling and treatment history. These histories will be reconstructed to the degree practical based on two databases as described below in the section Assessment of Treatment History.

This study is focusing on intertidal mixed-soft sediments[1]. Because most beaches with this sediment type are located in relatively protected areas, the shoreline will be stratified to include embayments and protected passages. Selection of areas with potentially suitable substrate types will be facilitated using both the PDF and GIS versions of NOAA's ESI Atlas for Prince William Sound. The GIS version of the atlas will be queried using the appropriate Shoreline Habitat Rankings employed in the database to identify areas within each stratum that have potentially suitable substrate. These will be further screened to eliminate exposed sites.

Within each of the strata, the potentially suitable sites will be cross-referenced with the shoreline segments in embayments and protected passages identified as having suitable oiling and treatment histories. Segments with favorable characteristics for substrate and oiling and treatment history within each stratum will be assigned an incremental number. The NOAA Shoreline Segment Summary and Department of Natural Resources GIS databases will be used to assist in this process. Finally, these

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[1] Sites with predominantly sandy or silty sediments, such as the northern end of Crab Bay, will be eliminated from further consideration because they typically support a substantially different bivalve fauna.

beach segments will also be stratified on the basis of beach elevation. Only beaches on which the appropriate sediment type is found between 0 and 0.8 m above MLLW will be considered. Because tidal elevation data are not available in the GIS databases, this determination will be finalized during the reconnaissance/site selection survey.

Six sites will be carried over into the sampling design from previous programs due to their historic value. These historic sites will include two reference sites (Outside Bay and Bainbridge Bight) and four oiled and treated sites (Northwest Bay West Arm, Shelter Bay, and Sleepy Bay) from the NOAA recovery and treatment effects program; and a high-pressure hot-water washed site from an Exxon beach cleaner study (Disk Island).

The proposed allocation of sites among strata is shown in Table 5. The number of sampling sites allocated to each cell is based roughly on the amount of shoreline available within each specific stratum. Allocation has also been tempered by the potential for finding suitable sites within a cell and the need to have at least three sites to provide reasonable estimate of variability.

Table 5

Allocation of Potential Sampling Sites Among Geographic and Spill Exposure Strata

Strata	Oiled and Treated	Unoiled Reference
Northern Insular	8 sites Northwest Bay West Arm, Disk Island + 6 random sites	3 sites Outside Bay + 2 random sites
Northern Mainland	3 random sites	3 random sites
Southern Insular	8 sites Shelter and Sleepy Bays + 6 random sites	3 random sites
Southern Mainland	3 random sites	3 sites Bainbridge Bight + 2 random sites
Total Sampling Sites	22	12
Number of Historic Sites	4	2
Number or New Random Sites	18	10

Assessment of Treatment History

Determining the treatment history for any particular stretch of shoreline is a somewhat difficult and complex task. However, it has been demonstrated by Mearns (1996) for several areas in the sound that it can be accomplished to a reasonable degree. For his analysis, he employed NOAA's Shoreline Segment Summary database. Based on that database, he was able to assign substrate type, relative degree of oiling (no-, light-, moderate-, or heavy oiling), types of treatment (e.g., moderate to high pressure or warm or hot water), number of types of treatment, and number of treatment days on a segment. He did this for 37 shoreline segments in Herring Bay and 31 segments on Eleanor and Ingot Island. He concluded that, although "... treatment varied greatly among shorelines,...treatment effort was generally proportional to the amount of oil present." According to his data for Eleanor and Ingot Islands, 81 percent of the heavily oiled sites were exposed to warm or hot water and 71 percent were exposed to both. In addition, 80 percent of the moderately oiled sites were exposed to warm or hot water. Only about 10 percent of the moderately or heavily oiled segments were not treated or did not have accompanying treatment characterization. From these data, one can conclude that most heavily or moderately oiled sites were washed with hot or warm water. Furthermore, it appears this data set provides relatively good insight into the oiling and treatment history of many shoreline segments.

In addition, an ArcView map set showing many of these same types of data provides similar information. This map set, a 1997 product of the EVOS Trustee Council prepared by Alaska Department of Natural Resources, is included on a compact disk entitled "EVOS Research and Restoration Information Project". This data set will be used in combination with the NOAA data to fill in gaps where possible.

Suitability Criteria for Site Selection

At least 50 sites will be visited and evaluated during the reconnaissance survey to evaluate their suitability as potential candidate sites. As described above, these sites will have been previously screened to assure, to the degree possible, they were moderately or heavily oiled and subsequently treated with high-pressure, hot- or warm-water treatment techniques. This screening will be based on applicable Shoreline Segment Summary databases.

During the visit, the suitability of the sites will be evaluated on the basis of the criteria described below. Unsuitable sites will be omitted from further consideration. Final selection of the random sites will be made by randomly selecting the appropriate number of sites from among the remaining pool of acceptable sites for each stratum.

The following criteria will be evaluated for each site in order to determine its suitability for inclusion in this study.

- Does the site have mixed-soft sediment (mixed fines, sand, pebbles, and boulders) between 0 and +0.8 m (+2.6 feet) above MLLW?
- Is there a 30-m long expanse of suitable sediment available for sampling at the appropriate elevation?
- Is the site located suitability far from any stream, river, or glacier that could expose it to depressed temperatures or a strong or sustained freshwater influence?

- Is the site subject to strong anthropogenic influences other than the effects of the oil spill and shoreline treatment (e.g., mine tailings, log dumps, or marina activities)?

Note that the species composition and abundance of bivalves are not included as suitability criteria. Because two major hypotheses involve species composition and abundance, using these variables as site selection criteria would bias the results, especially for the reference sites.

Bivalve Sampling

Sample Collection and Handling

Samples for the bivalve assemblage will be collected with core samplers 10.7-cm in diameter (0.009 m^2) by 15-cm deep. Five of these cores will be collected at randomly selected locations along a 30-m horizontal transect placed at the appropriate elevation at each site. To the degree possible, the elevation sampled will be standardized among sites.

Each sample will field sieved through a 1.0-mm screen, washed into a double-labeled Ziploc bag, and fixed with buffered 10% formalin-seawater solution. After several days, we will replace the formalin-seawater solution with isopropyl alcohol. The preserved samples will be stored in water-tight plastic buckets and shipped to the taxonomic laboratory at the completion of the field work.

Lab Analysis

Following receipt of the samples in the laboratory, they will be washed by elutriation and the bivalves will be preserved in isopropyl alcohol. The remainder of each sample will be discarded. The bivalves subsequently will be sorted, identified to the lowest appropriate taxon, and enumerated.

A representative sample of each bivalve taxon will also be measured to provide insight into the size structure and biomass of the populations living at each site. Length measurements will be made with vernier calipers or ocular micrometers, as appropriate.

Sediment Characteristics

Whole sediment samples will be collected at all sites for analysis of particle grain size, total organic carbon (TOC), and total Kjeldahl nitrogen (TKN). These samples will be composited from surficial sediments scooped approximately 2 cm deep at points immediately adjacent to the randomly selected sampling locations for collection of the bivalve cores. Thus, the single composite sample will not provide a measure of within-site variance for the sediment variables but this measure is not viewed as necessary for the purposes of this study. Each composited sample will be preserved by freezing.

These will be analyzed to provide information on a suite of pertinent sediment property covariates that appeared important to the development of infaunal assemblages in our previous studies.

Particle Grain Size

Particle grain size distributions will be determined using a pipette method (Plumb 1981) modified to correct for dissolved solids (i.e., salinity and the dispersant added to keep silt/clay particles from clumping).

Organic Nutrients (Total Organic Carbon and Total Kjeldahl Nitrogen

The samples used for analysis of organic nutrients in the sediments will be purged of inorganic carbon, dried at 70°C, ground, and sieved through a 120-mesh screen. TOC will be measured on a Dohrman DC-180 Carbon Analyzer using EPA method 415.1/5310B. TKN will be measured using EPA Method 351.4.

Statistical Analysis

Two types of statistical analyses will be used in this study, namely inferential and exploratory analyses. The inferential statistics will test, for example, specific values or indices (e.g., species richness or density of an indicator bivalve species) to measure the significance of the difference between the controls and treated sites. Where possible, an exact probability and the power of the statistic will be stated. Typically, we prefer to use randomization or permutation statistics (Edington 1987; Manly 1997) in contrast to the classical parametric techniques. These computer-intensive methods require none of the assumptions of equality of variance or normal distribution of data as do the parametric techniques. They rely solely on a truly random sample and the empirical distribution of the data to calculate the exact significance of the statistic.

Most of the inferential statistics will be either two-sample t-tests or simple ANOVAs although the procedures can be modified for more novel designs. The tests will be either one- or two-tailed, depending on our ability to predict the impacts from prior data. While acknowledging the inherent dangers of multi-comparison testing (i.e., you are likely to find some positive results based solely on probability rather than a real effect; also termed losing control of the alpha error), we will be looking for overall trends of significant effects and supporting evidence from the exploratory analyses rather than relying on any "critical" inferential decision result. Thus, Bonferroni corrections to experiment-wise alpha will not be used.

Exploratory analyses would include some appropriate combination of multivariate analyses. It might be as simple as graphically looking at various stratum- or species-specific histograms for the bivalve species or as complex as a full-blown ordination and clustering exercise using multi-species biological and physical data (Clarke 1993). This form of analysis can be quite useful to discern and interpret common or correlated patterns in the data but is difficult to quantify with probability values. However, exploratory analyses are invaluable for providing an understanding of the natural processes that is sufficient to interpret the inferential findings and to formulate testable hypotheses.

Statistical Power

Power analyses are useful to this project for two purposes: to estimate the number of replicates appropriate to study's statistical goals, and after data are collected, to understand the sensitivity of the inferential tests.

First, using as pilot data the latest available set of infauna data (NOAA, 1996), the sampling variances can be used to calculate the sampling intensity (number of replicates) required to detect an appropriate size of effect. The statistic of concern is the difference in individual species abundance (or species richness, total abundance, sediment fraction, TPAH, etc.) between reference and oiled and treated sites. The infauna pilot data set contains 3 sites (replicate means) in each category, n= 3, 3. Power analyses projected combinations of replication up to n = 25, 25 using the reported sampling variances. The species with the best power to detect an effect (i.e., highest power for lowest practical effect) are suggested as primary indicator species for discriminating the reference from the oiled and treated sites (Table 6).

Table 6

Power to detect proportional differences in species abundance between reference and oiled and treated sites. Calculations are based on 1996 data (n = 3,3), for a 2-sample t-test for the difference of means using alpha = 0.10, pooled variance and sampling intensity of n = 10 and 20 replicates, respectively, for reference and oiled and treated sites. Values with power exceeding 50% and potential indicator species are bold formatted.

	Reference		**Oiled and Treated**		**Proportionate Detectable Effect (percent)**				
Taxon	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**100**	**75**	**50**	**25**	**10**
Diplodonta aleutica	0.0	0.0	0.7	1.2	**81**	**60**	35	17	11
Mysella tumida	50.0	75.5	4.0	3.6	**83**	**62**	37	17	11
Macoma spp.	9.0	7.8	0.0	0.0	**100**	**98**	**81**	35	14
Macoma balthica	17.0	14.9	0.0	0.0	**100**	**98**	**81**	35	14
Saxidomus gigantea	0.7	1.2	0.0	0.0	**81**	**60**	35	17	11
Protothaca staminea	12.7	11.2	1.0	1.0	**100**	**100**	**97**	**54**	18
Mya arenaria	1.0	1.0	0.0	0.0	**100**	**97**	**76**	32	14
Hiatella arctica	1.7	2.1	21.3	24.4	**91**	**72**	44	19	11

The second utility of power analyses comes during *post-hoc* calculations wherein the actual power of the significant results is reported. For example, a difference in the abundance of a single species between two treatment categories may be statistically significant ($p < 0.05$); however, the ability to detect a meaningful change may not be very powerful. If the power analysis reported a power of 0.50 for a 100% change in a species abundance, it means that although you have only a 5% chance of wrongly proclaiming the change was real, you also have a 50% chance of missing a real change that was less than a 100% difference.

A concern arises in estimating power for randomization statistics; currently no formula are available s to use for the calculations. However, based on the knowledge that a randomization test produces precisely the same result as a comparable parametric test when applied to normally distributed data, the power of randomization tests is inferred to be equal to parametric tests in that ideal case. As a data distribution deviates from normality, the assumptions for the parametric test are violated and power is compromised. However, under these circumstances, the randomization test results are unaffected and power is assumed to remain roughly the same. For our purposes, we must rely on calculations of parametric power to estimate the power of the randomization tests.

Bivalve Variables

Inferential testing for comparing bivalve variables between reference and oiled and treated sites will be accomplished using 2-sample t-tests for the selected indicator species and population indexes. If needed, size frequencies will be tested using either a Kolmogorov-Smirnov test or the alternative weighted Anderson-Darling test. Two-way ANOVAs will be used to test for stratified category effects. Multivariate analyses will likely follow the combined NMDS and clustering techniques described in Clarke (1993).

Sediment Characteristics

Physicochemical sediment characteristics will be tested for category effects using 2-sample t-tests. The data will also be examined for correlations with various species and as covariates to the multivariate ordinations.

Comparison Between Site Categories

The following categories will be compared , using 2-sample t-tests or stratified 2-way ANOVAs:

- All oiled and treated vs all reference sites
- New oiled and treated vs new reference sites
- New oiled and treated and NOAA Category 3 (oiled & treated sites carried over from previous studies)

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Not Applicable

SCHEDULE

The first year of this project will focus on three major items. These include: 1) selection of appropriate sampling locations, 2) conduct of the field sampling program, and 3) laboratory analysis of bivalve and sediment samples. The field work (reconnaissance survey and field sampling program) will be conducted during the two spring tide series in June 2002.

The samples will be received by the laboratories in July 2001 so it is unlikely that results will be available until October 2002. Consequently, we do not anticipate completion of data entry and database development until December 2002.

A. Measurable Project Tasks for FY 02 (October 1, 2001 – September 30, 2002

December 1 –15, 2001 Arrange and finalize contracts with subcontractors

December 16 Commence sampling site selection process by review of appropriate SCAT and shoreline treatment records

January 14 - 23 (2 days) Attend Annual Restoration Workshop; initiate dialog with knowledgeable native regarding location of historical subsistence clam harvest sites

March/April Arrange air/vessel support logistics and contracts

April 13 Submit progress report; no data available for FY 02 at this point.

May 15 Finalize list of candidate sampling sites

June 9 – 16 Conduct reconnaissance survey to finalize selection of sampling sites

June 22 - 30 Conduct field sampling program

June 30 Ship bivalve and sediment samples to respective labs for analysis

July 15 – 30 October Analysis of bivalve and sediment samples

Most of the data analysis, report and manuscript preparation, and presentation of the results at the annual restoration workshop and at a national conference, will occur during the second year of the project (FY 03).

B. Project Milestones and Endpoints

The objectives for this program are to evaluate: 1) whether or not the depressed condition of bivalve assemblages at treated sites observed in our earlier work is general to treated sites throughout western Prince William Sound; and 2). the role that several sediment characteristics in may play in the apparent depression of bivalve assemblages in treated sediments. The objectives for this program will be addressed concurrently starting in June 2001 by collecting bivalve and sediment samples at numerous oiled and treated and unoiled reference sites in western Prince William Sound.

FY 02

January 14 - 23 (2 days) Attend Annual Restoration Workshop

April 15 Arrange air/vessel support logistics and contracts

May 15 Finalize list of candidate sampling sites

June 16	Complete reconnaissance survey.
June 20	Finalize selection of sampling sites
June 30	Complete field sampling program
July 2	Ship bivalve and sediment samples to laboratories
October 30	Complete analysis of bivalve and sediment samples

FY 03

November 1	Commence data entry and analysis
December 31	Complete analyses of bivalve and sediment data
January 15, 2003	Commence preparation of annual report describing findings of the FY 02 field survey
February 15	Commence preparation of presentation describing the findings of the bivalve studies
April 13	Submit annual report (FY 02 findings)
May 1	Commence preparation of manuscript for peer-reviewed journal describing the findings of the bivalve studies

Laboratory analysis of those samples will require at least 3 months, following which we evaluate the data to address the questions posed by the objectives.

C. Completion Date

The program described in this proposal will be completed in the 3rd quarter of FY 03, in time for presenting final results and conclusions in the annual report describing FY 02 findings. The findings will be submitted as a manuscript to a national peer-reviewed journal and at a national conference during FY 03.

PUBLICATIONS AND REPORTS

At least two deliverables will be produced from the proposed research. The first will be the April 2003 annual report to EVOS Trustee Council for project activities in FY 2002. This annual report will be the final report for this program.

Moreover, assuming this research is funded, we will prepare a publication for a peer-reviewed journal. This paper, combining the findings of this work with those of the NOAA studies, will be submitted in Fall 2003 to Marine Ecology Progress Series or Ecological Applications. The title of this paper will be "Long-term Recovery Patterns in Prince William Sound Intertidal Bivalves Following *Exxon Valdez* Oiling and Shoreline Treatments, 1989 through 2002," If this

proposal is not funded, a paper entitles "Response and Recovery of Intertidal Infaunal Bivalves Exposed to the *Exxon Valdez* Oil Spill and Related Shoreline Treatment at Selected Sites in Prince William Sound," based solely on the NOAA studies, will be submitted in Summer 2002 to one of the same journals.

Concerns that the results from this research might not be published were summarized in the initial review of this proposal. Reviewers should be aware that the team that participated in NOAA's initial studies on the effect of shoreline treatment in Prince William Sound has recently published the first of a series of papers on our studies of the *Exxon Valdez* Oil Spill. This paper (Driskell, W. B., J. L. Ruesink, D. C. Lees, J. P. Houghton, and S. C. Lindstrom. 2001. Long-term signal of disturbance: *Fucus gardneri* after the *Exxon Valdez* oil spill. Ecological Applications 11:815-827) examines synchronized senility in individual plants forming a population. Synchronized senility led to population crashes about 4-5 years following the cleanup. We demonstrated that these crashes were a consequence of reduced diversity in age structure resulting from obliteration of pre-cleanup populations of rockweed. Continued surveys in the region observed similar but weaker declines in 2000 (Dr. Alan Mearns, pers. comm.)

Regarding other publications of the NOAA studies, Mr. Lees currently has a manuscript about 80-percent complete on the response and recovery of intertidal infaunal bivalves exposed to the *Exxon Valdez* Oil Spill and related shoreline treatment (indicated as a manuscript above). We have delayed completing this paper until we know the decision on this proposal. The conclusions of that paper, reflected in both the presentations that we have made at national conferences and in this proposal, are that shoreline treatment has caused considerable disturbance to the intertidal bivalve assemblages at treated sites, and that these assemblages are recovering only at a very slow rate, in contrast to assemblages at oiled but untreated sites. Because the objective of this proposal is to determine if this pattern is, in fact, general to the treated areas in Prince William Sound, it seems that the best approach for publishing the results would be to combine both data sets into a single paper. This strategy has benefits whether the results of the effort proposed herein either confirm or refute the findings of the NOAA studies. Either alternative can be addressed and integrated in the same paper and we would avoid placing potentially erroneous conclusions into the oil-spill literature by premature publication of the NOAA conclusions. If the findings of this research are ultimately supportive, publication of the results of the EVOS-funded work in a separate and subsequent paper would seem more like an afterthought to the original paper.

Finally, rather than allowing this concern to deny funding for the proposed study, we would suggest specifying in the contract a hold on payment of a reasonable proportion of the second year's funding until the proposed integrated manuscript is submitted for review by a peer-reviewed journal.

PROFESSIONAL CONFERENCES

No funds requested at this time. Probable attendance at the 2003 International Oil Spill Conference and the 2003 SETAC Conference to present papers on findings of this program.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

We have coordinated with Dr. Henry Huntington to develop a Community Involvement program and gain access to traditional knowledge that we intend to use in selection of sample sites. Those aspects are described above in this proposal.

We anticipate sharing information with Steven Jewett, Univ. of Alaska, Fairbanks, James L. Bodkin, USGS, and Thomas Dean, Coastal Resources Associated, Inc. Furthermore, we will discuss our findings with Glenn VanBlaricom and Allan Fukuyama to exchange with information with their subtidal programs.

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

Dennis C. Lees

With over 30 years of national and international experience, Mr. Lees has extensive capabilities in the study and evaluation of nearshore and intertidal benthic systems ranging from the Beaufort Sea and Chukchi Sea in Alaska to California, Micronesia, and the Arabian Gulf. He has been a pioneer in the research of intertidal and shallow subtidal ecology in Cook Inlet and Prince William Sound and has performed intertidal or subtidal surveys at numerous other locations in the state including Prudhoe Bay, the eastern Chukchi Sea, the Bering Sea, Unalaska, Akutan, Shelikof Strait, and the Outer Kenai Peninsula. He has participated in a variety of field, analytical, and reporting activities as a principal investigator or project manager. He has assessed or predicted impacts for a wide spectrum of industrial development activities on coastal marine habitats around the world. He has strong experience in evaluation of impacts from oil-and-gas and mining exploration and development, oil and ore spills and related clean-up and treatment activities, especially in Alaska, construction and operation of petrochemical, power, desalination, and wastewater treatment facilities, and port and airport construction and operation.

Specific experience related to oil spills and Alaskan marine systems includes:

- Recent experience in oil spill assessment and evaluation of treatment methodologies on the *Exxon Valdez* Oil Spill in Prince William Sound, the outer Kenai Peninsula, and Cook Inlet for NOAA and Exxon.
- Baseline studies of intertidal biota in Prince William Sound, Outer Kenai Peninsula, and upper and lower Cook Inlet.
- Completion of an important reconnaissance survey and comprehensive analysis of factors controlling infaunal assemblages in upper Cook Inlet.
- Completion of an Ecological Risk Assessment evaluating risks to the water column and intertidal habitats of coal-water fuel spills in upper Cook Inlet.
- Recent and continuing experience in pre- and post-abandonment (decommissioning) projects in the Santa Barbara Channel with special emphasis on surveying and restoration efforts for kelp, eelgrass, and surfgrass resources.
- Extensive experience in sampling and analysis of sediment contamination and benthic and demersal fish communities associated with rocky and soft substrates and kelp beds along the west coast of the United States and Alaska.
- Extensive experience with environmental assessments for the development phase of offshore and coastal oil and gas development and refinery operations in California, Alaska, and the Arabian Gulf

Mr. Lees obtained his B.A. in Zoology from UCSB, an M.S. in Biology from San Diego State University (SDSU), and completed all but the dissertation requirements for a Ph.D. in a joint doctoral program for SDSU and University of California, Riverside.

Mr. Lees participates in and manages a variety of marine science and environmental activities focusing on marine ecological risk assessment, habitat restoration, sediment and effluent toxicity testing, as well as traditional marine ecological assessment of benthic and nearshore fish communities. His research experience has been concentrated in evaluation of contaminant impacts in intertidal and nearshore biological systems in bays, estuaries, and coastal regions ranging from Alaska and California to the Arabian Gulf. From 1989 to 1996, he served as a project manager and principal investigator on a series of multi-year marine biological studies of intertidal and shallow subtidal habitats in Prince William Sound to study: 1) the initial impacts of the *Exxon Valdez* oil spill; 2) biological costs and effects of shoreline treatment following the oil spill; and 3) long-term effects and recovery of the biota. He participated in a major ecotoxicological study to determine the effects of spilled copper ore on the biota in marine sediments in San Diego Bay. Other sediment quality studies in which he has participated include dredging feasibility studies at the Sub Base, 32nd Street, and Continental Maritime of San Diego, and PCB evaluations at Convair Lagoon. Recently, he has been involved in eelgrass and kelp resource assessments and subsequent restoration and mitigation programs. He has assessed or predicted impacts on nearshore marine habitats from a wide variety of industrial development activities, including construction and operation of port facilities, power, desalination, petrochemical, and wastewater treatment facilities, oil development, oil spills and related clean-up and treatment activities. He participated in development of ecological risk assessment programs for Pearl Harbor and Guam as part of Ogden's Navy CLEAN program for PACDIV. He was project manager and principal investigator on major biological studies of the demersal fishes, zooplankton, benthic assemblages, wetlands, and coral reefs in two regions in the Arabian Gulf to monitor the development of a major petrochemical industrial complex, associated large power and desalination plants, and operation of a major supertanker port.

OTHER KEY PERSONNEL

All of the key personnel worked together in Alaska on major projects reaching back to 1975. We have well established working relationships.

A. William B. Driskell – Sampling Design and Statistical Approach

Mr. William Driskell will design the sampling program for this study. Moreover, he will be in charge of the various databases required for the various kinds of data and statistical analyses. In 1988, Mr. Driskell began a computer and marine biological consulting business in Seattle dealing primarily with scientific databases and statistical analyses ranging from sampling designs to multivariate statistics. He has worked as a marine biologist for the past 25 years, principally in the south-central Alaska and the Puget Sound regions but interrupted by a three-year sojourn in the Middle East where he participated in major baseline and effluent effects studies. He has been working in Prince William Sound since 1977 and on the *Exxon Valdez* oil spill since March 1989. His specialties applicable to this program are statistics, data management and computer programming. His expertise also includes: taxonomy of North Pacific and Arabian Gulf marine invertebrates and fish; biological survey techniques including trawl, seine, diving, benthic grab, dredge and box core, underwater television and still photography; and bird identification.

B. Laboratories

Bivalve Assemblages – Littoral Ecological & Environmental Services

Sorting, identification, and measurement of the bivalves in the samples obtained in July 2002 will be conducted in the laboratory of Littoral Ecological & Environmental Services, under the direct supervision of Mr. Dennis Lees.

Sediment Characteristics – To Be Determined

The laboratories in which these routine analyses (particle grain size, total organic carbon, and total Kjeldahl nitrogen), will be conducted will be determined after contract award.

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Approved 12-11-01

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel		$0.0
Travel		$0.0
Contractual		$88.6
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$88.6
General Administration		$6.2
Project Total	$0.0	$94.8
Full-time Equivalents (FTE)		0.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
Estimated FY 2003					
$35.3					

Dollar amounts are shown in thousands of dollars.

Comments:

FY02

Prepared:12/14/01

Project Number: 02574-BAA
Project Title: Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in PWS
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

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FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$42.2						
Travel		$6.6						
Contractual		$37.5						
Commodities		$2.3						
Equipment		$0.0						
Subtotal	$0.0	$88.6	Estimated FY 2003					
Indirect								
Project Total	$0.0	$88.6	$33.0					
Full-time Equivalents (FTE)		0.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY02

Prepared: 4/9/01

Project Number: ~~Not Assigned~~ 02574-BAA
Project Title: Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound
Name: Dennis C. Lees

FORM 4A
Non-Trustee
SUMMARY

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2002
	D. Lees	Principal Investigator, Infaunal Analyses	1.9563	12.8		25.0
	W. Driskell	Sampling Design and Statistics	1.3563	9.6		13.0
	Unid. Field Techs	Sample collection and processing	0.6563	6.4		4.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	4.0	28.8	0.0	
					Personnel Total	$42.2

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2002
	D. Lees, San Diego to Anchorage, annual Restoration mtng	0.8	1			0.8
	D. Lees, San Diego to Anchorage, Travel to point of departure for field surve	0.8	1			0.8
	W. Driskell, Seattle to Anchorage, Travel to point of departure for field survey	0.65	1			0.7
	Field tech, San Diego to Anchorage, Travel to point of departure for field sur	0.8	1			0.8
	Auto rental during meeting and field study	0.04	8			0.3
	Per diem			27	0.12	3.2
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$6.6

FY02

Project Number: Not Assigned
Project Title: Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound
Name: Dennis C. Lees

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/9/01

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:	Proposed
Description	FY 2002
Sediment Grain Size, 34 samples	5.4
Infaunal Analyses, 170 samples	8.5
Air Charter, 42 hours of air support for reconnaissance	11.6
Vessel Charter, 8 days charter, providing transportation, lodging, and food for field crew	12.0
Contractual Total	$37.5

Commodities Costs:	Proposed
Description	FY 2002
Shipment of equipment and samples	0.4
Film & Processing	0.1
Field Supplies & Expendables	0.8
Printing, xerox, and phone	1.0
Commodities Total	$2.3

FY02

Prepared: 4/9/01

Project Number: Not Assigned
Project Title: Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound
Name: Dennis C. Lees

FORM 4B
Contractual & Commodities DETAIL

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2002
Description			
Not Applilcable			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number of Units	
Description		
Not Applilcable		

FY02

Project Number: Not Assigned
Project Title: Assessment of Bivalve Recovery on Treated Mixed-Soft Beaches in Prince William Sound
Name: Dennis C. Lees

FORM 4B
Equipment
DETAIL

Prepared: 4/9/01