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EXXON VALDEZ OIL SPILL DETAILED PROJECT DESCRIPTION

Project Title: Harlequin Duck Population Dynamics and Satellite Telemetry

Project Number:	00407
Restoration Category:	Monitoring, Research
Proposer:	Alaska Department of Fish and Game
Lead Trustee Agency:	Alaska Department of Fish and Game
Cooperating Agencies:	USFWS, USGS-BRD
Alaska SeaLife Center:	No
Duration:	3 years
Cost FY00:	$110,100
Cost FY01:	$110,100
Cost FY02:	$110,100
Geographic Area:	Prince William Sound
Injured Resource:	Harlequin ducks

ABSTRACT

Harlequin duck (*Histrionicus histrionicus*) populations have not recovered from the effects of the *Exxon Valdez* Oil Spill. Populations are declining in oiled areas of Prince William Sound (PWS), while increasing in unoiled areas. Proposed late-winter boat surveys have been designed to assess the recovery of ducks inhabiting oiled areas. Population structure, abundance, and recruitment will be compared between oiled and unoiled areas in PWS to assess trends, population dynamics, and the progress of recovery. During these surveys, 10 males in oiled areas will be captured and implanted with satellite transmitters. This will provide information on pre- and post breeding movements within PWS, dispersal, migration routes, and location of breeding areas. This critical life-history information is lacking for PWS harlequin ducks and will aid in understanding causes of population declines and assessing recovery.

INTRODUCTION

Harlequin duck (*Histrionicus histrionicus*) populations are declining in oiled areas of Prince William Sound (PWS) while they are increasing in unoiled areas (Rosenberg and Petrula 1998). Additionally, harlequin ducks inhabiting oiled areas are at greater risk to hydrocarbon exposure and have lower female survival (overwinter) than ducks in oiled areas (Holland-Bartels, in prep.). In combination, these two studies provide strong evidence that harlequin ducks have not recovered from the effects of the *Exxon Valdez* oil spill (*Exxon Valdez* Oil Spill Trustee Council 1999).

Harlequin ducks occur year-round in intertidal zones of PWS (Isleib and Kessel 1973). At least 1,298 harlequin ducks were estimated to have died as a direct result of oil exposure following the Exxon Valdez oil spill (J. Piatt pers. comm.). Oil spill studies of harlequin ducks in western Prince William Sound (PWS) from 1990-93 found consistently low numbers of birds during the breeding season, little breeding, low productivity, and an apparent decline in post-breeding molting birds (Patten 1995, Patten et al. 1995). In 1995, six years after the Exxon Valdez oil spill there was no sign of recovery (Exxon Valdez Oil Spill Trustee Council 1996).

As a result of the 1990-1993 findings and the lack of recovery, ADF&G initiated population monitoring in 1994 (Rosenberg 1995; Rosenberg et al. 1996; Rosenberg and Petrula 1997; Rosenberg and Petrula 1998). These studies, conducted from 1994 through 1997, found no difference in population structure between oiled and unoiled areas; no brood production in the spill area; and a decline in molting populations. Similar population structures, a positive finding, indicated that the population was in a position to recover. However, the declining trend in numbers during autumn surveys for the oiled areas of western PWS remained a concern, especially since populations in unoiled eastern PWS increased. This indicated that recovery has not occurred.

We believe the lack of brood production in the oiled areas is a function of limited breeding habitat, not oil history. A relatively small percentage of harlequin ducks that winter in PWS also breed in PWS (Rosenberg and Petrula 1998). Ten years after the spill, we do not know where the majority of the PWS wintering population of harlequin ducks breed. We suspect the vast majority breed outside of PWS, likely in interior Alaska or the Yukon Territory, Canada (Rosenberg and Petrula 1998). Therefore, productivity information collected within PWS can not be extrapolated to the larger population and used to assess recovery. We cannot compare annual productivity and recruitment; link this information with monitoring results, oil history, and hydrocarbon exposure; and assess factors on the breeding grounds that may limit or retard recovery, without first knowing where PWS harlequin ducks nest.

Two other studies have been monitoring the survival and population trends of harlequin ducks in PWS. The decline in the number of harlequin ducks in WPWS that we observed is supported by results from the Nearshore Vertebrate Predator (NVP) project (Holland-Bartels, in prep.). The NVP study indicates a significantly lower ($p<0.10$) survival rate (76.6%) for females wintering in oiled areas than for females wintering in unoiled areas (86.6%). Lower survival rates may be related to the significantly higher ($p<0.01$) EROD (ethoxyresorufin-O-deethylase) enzyme activities (an enzyme indicative of exposure to aromatic hydrocarbons) measured in liver tissues taken from harlequin ducks and Barrow's goldeneyes (*Bucephala islandica*) in oiled areas

(Holland-Bartels, in prep.). Harlequin ducks in oiled areas (WPWS) are still being exposed to hydrocarbons, although the effects remain uncertain.

The USFWS marine boat surveys (Agler et al. 1995; Agler and Kendall 1997) have been monitoring marine birds, including harlequin ducks, throughout PWS since 1989. These surveys which were not designed to be species specific, gather information on abundance and distribution only; they have not collected information on population structure. Their findings show harlequin ducks in July remaining relatively stable in oiled areas and increasing in unoiled areas. In March, their surveys show a slight increase in the number of ducks inhabiting oiled sites. This compares with a much greater rate of increase for unoiled areas. Some inconsistency is evident between the ADF&G surveys (Rosenberg and Petrula 1998) and the USFWS surveys (Agler and Kendall 1997). A detailed comparison of the two surveys is presented in Rosenberg and Petrula (1998).

Despite any inconsistencies in survey results, all three studies (Agler and Kendall 1997; Holland-Bartels, in prep.; Rosenberg and Petrula 1998) indicate a divergence between oiled and unoiled populations. Harlequin duck populations in oiled areas (WPWS) are consistently "under-performing" populations in unoiled areas (EPWS). Yet, questions still remain as to the cause of this divergence, and whether survey results primarily reflect lingering effects of the oil spill or extrinsic factors such as local ecology and climate at the breeding, molting, or wintering areas

Sea duck populations, in general, are composed of relatively long-lived birds with delayed sexual maturity. Productivity may be limited to a few favorable years and population levels may change slowly. Long-term population stability depends on high adult survival coupled with a few years of successful reproduction. Initial high losses of adults, especially females, may result in a long and slow recovery period, especially if initial causes of mortality are still influential.

Numerous activities, natural or man-made, such as hydroelectric development, water pollution, or recreational activites on the breeding, wintering, or molting areas potentially have profound affects on abundance or distribution of a population. The lack of information on breeding and migration patterns can prevent the identification of potential harmful environmental exposures or alterations and make it extremely difficult to determine possible causes of population declines. Location of and links between breeding grounds, migration routes, and molting and wintering areas are important factors used to evaluate contaminant uptake or loss in a migratory species as well as changes to food resources and other environmental changes (Henny et al. 1991). Nesting is considered one of the weakest links in the life cycle, especially with regard to contaminant effects (Henny et al. 1995).

We propose to conduct a winter survey that will compare population trends in the same oiled and unoiled areas surveyed in project \427 (Rosenberg and Petrula 1998). In addition, we propose expanding the geographic coverage of the survey to allow us to compare regional differences in population trends within oiled and unoiled areas. Thus, we will compare trends for different geographic regions within oiled and unoiled areas in an attempt to assess geographic effects. We have designed a survey that has the power to detect trends in oiled populations, provide information on population demographics, and shed insight into geographic differences within PWS.

During this survey period, we also propose capturing 10 male harlequin ducks in the oiled area and implanting them with satellite transmitters. The potentially vast geographic range of the birds between winter and nesting areas, makes conventional telemetry impractical for the initial identification of nesting areas. Satellite telemetry studies offer the best method for initially identifying pre- and post breeding movements, dispersal, migration routes, and location of breeding areas. Satellite transmitters were successfully used to track the movements and locate nesting sites of male harlequin ducks in eastern North America (Brodeur et al. 1998). Males have exhibited a more rapid rate of decline in oiled areas than females (Rosenberg and Petrula 1999). This may result from lower survival rates or dispersal.

In subsequent years, we will be able to expand the geographic extent of the breeding range; identify specific nest sites and assess productivity; link breeding areas with molting areas in both oiled and unoiled PWS; and measure dispersal and recruitment. This will be accomplished by mist-netting adults and trapping broods on breeding streams and using a combination of satellite transmitters, less expensive VHF transmitters, and leg bands. This effort will benefit from and expand upon the large number of individuals currently marked as part of the Nearshore Vertebrate Predator project (Holland-Bartels, in prep.)

About 150 females in oiled areas have been permanently implanted with VHF transmitters in the abdominal cavity (Holland-Bartels, in prep.). Although short-term mortality rates, as a result, are low (Mulcahy et al., in press) little is known about the long-term consequences of these implants. As variation in female survival has profound influences on population dynamics, we believe it more prudent to conduct these experiments on males, which are more abundant in the population and are larger in size and therefore more capable of carrying the transmitter. Although, males are less likely to migrate to breeding grounds (Rosenberg and Petrula 1999), we believe by choosing paired adult males we can select likely breeders. Any non-breeders will shed insight into dispersal.

This project is allied with harlequin duck studies being conducted as part of the continuation of the Recovery of Nearshore Vertebrate Predators (project /025). It is essentially a continuation of Project /027 Harlequin Duck Recovery Monitoring with an added component for identifying breeding areas. No work was conducted on project /027 in FY99. This project will continue to monitor harlequin duck populations in oiled and unoiled areas of PWS. However, we will now conduct surveys, one per year, during March. Throughout much of the year, harlequin duck populations are in a state of flux as birds move to and from breeding areas. Subadults may also be quite mobile in a quest to find mates. March is a period when pair bonds are well formed, and there is relative stability in both numbers and movements of harlequin ducks.

NEED FOR THE PROJECT

A. Statement of Problem

Harlequin ducks have not recovered from the effects of the *Exxon Valdez* oil spill. Populations in oiled areas are continuing to decline (Rosenberg and Petrula 1998). Declining molting populations, coupled with low female survival, and exposure to hydrocarbons in oiled areas are all indicative of a lack of recovery and continued oil spill effects. Residual oil in the nearshore environment has the potential to interfere with physiological processes. Two main hypotheses have been presented to

explain population declines: (1) ingested oil is continuing to cause either mortality and/or sublethal impairment of reproduction; and/or (2) initial mortality caused significant losses to the western PWS population which may result in a protracted recovery period.

However, questions still remain as to the cause of this decline, and whether survey results primarily reflect lingering effects of the oil spill or extrinsic factors such as local ecology and climate at the breeding, molting, or wintering areas. Location of and links between breeding grounds, migration routes, and molting and wintering areas are important factors used to evaluate environmental changes (Henny et al. 1991). Nesting is considered one of the weakest links in the life cycle, especially with regard to contaminant effects (Henny et al. 1995). Long-term data on population trends and sex and age composition and are necessary to evaluate recovery. Identification of nesting areas is an important step to assess environmental changes.

B. Rationale/Link to Restoration

This proposed work represents a relatively simple, workable approach to the long-term monitoring of harlequin duck populations that will allow us to assess recovery from the spill. We propose a survey that has proven to have the power to detect trends in oiled populations, give us valuable information on population demographics, and provide insight into geographic differences within PWS. This study is directly linked to the recovery objectives for harlequin ducks in the EVOS Restoration Plan (Exxon Valdez Oil Spill Trustee Council 1999). This project will provide winter population trends; compare population structure, and provide an index of recruitment between oiled and unoiled areas.

The research component of this project will allow us to identify nesting areas and will provide additional insight into understanding factors affecting population dynamics and inhibiting recovery. Restoration efforts will be improved by identifying breeding areas and migration routes. Identification of breeding areas and migration routes will allow for improved habitat protection via acquisition, recreational and land-use planning, permitting, and pollution control. Harlequin ducks exhibit strong fidelity (philopatry) to nesting sites and the protection of nesting and brood rearing areas is paramount to the recovery of this species.

Information from this project will aid in the development of a population model. A population model is central to monitoring harlequin duck recovery. The model must include demographic parameters and identification of critical periods of the annual cycle that may limit recovery from the *Exxon Valdez* oil spill. This will allow researchers to predict population trends and rate of recovery. While some of this information has been collected for PWS populations (Holland-Bartels in prep.; Rosenberg and Petrula 1999) and harlequin ducks in North America (Goudie et al. 1994; Robertson 1997), many specifics are still lacking, including data on productivity, recruitment, dispersal, and subadult survival. Population monitoring will test the demographics predicted by the model.

Harlequin ducks are highly philopatric to breeding, molting, and wintering sites. This is an adaptive strategy in natural situations and predictable environments. It is not favorable in the face of dramatic environmental perturbations or rapidly changing land-use practices. It does not

favor rapid recovery and colonization of new undisturbed sites. This strong philopatry may result in continued exposure to residual oil or delays in pioneering new nest sites once populations stabilize. Continued monitoring on the wintering sites, combined with breeding site identification provides a comprehensive approach to recovery that can be used to assess and improve recovery.

It takes a minimum of three years before population trends can be determined. Therefore, monitoring should begin as soon as possible. Annual monitoring is proposed. Populations may vary considerably from year to year. Detecting upward or downward trends in abundance and productivity from year to year variations will be met sooner with increased sampling. Results of this work will have a direct bearing on assessing the status and outlook for this resource and help guide agency programs and policies related to public uses, especially subsistence and recreational hunting, land-use practices, and wildlife viewing.

C. Location

The proposed project will be conducted in the oil spill area of western Prince William Sound and unoiled eastern PWS between Valdez and Cordova and northern Montague Island. Survey sites in PWS will be located in the same areas used for the harlequin duck component of project \025 Nearshore Vertebrate Predator Project and project \427 Harlequin Duck Recovery Monitoring (Rosenberg and Petrula 1998, in prep.), with some additional sites in southwestern PWS. Surveys in the spill area will focus on Knight Island, Applegate Island, Foul Bay, Main Bay, Eshamy Bay, Crafton Island, Chenega Island, Green Island, Naked Island, and Bainbridge, Evans, and LaTouche islands in southwestern PWS. Surveys in non-oiled areas will include portions of Hinchinbrook Island, Simpson Bay, Sheep Bay, Port Gravina, Landlocked Bay, Bligh and Busby islands, Galena Bay and Valdez Arm, and Montague Island. Communities affected by the project include Chenega, Tatitlek, Whittier, Valdez, and Cordova.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The project will continue to inform and coordinate our community involvement activities. This effort began with project /427 (Harlequin duck recovery monitoring) and a TEK report is included in Rosenberg and Petrula 1998. This effort was continued with project /273 (Scoter life history and ecology: linking satellite telemetry with traditional ecological knowledge). The collection of indigenous knowledge has been coordinated with Dr. Henry Huntington, TEK specialist Chugach Regional Resources Commission and Hugh Short, Community Coordinator, EVOS Restoration Office. We will continue to solicit advice from the above parties and gather information on TEK through synthesis workshops, local community facilitators, and residents as part of project /273.

Efforts have and will continue to be made throughout the restoration process to participate in and provide public involvement in the design and implementation of this project. In concert with project /273 information gathered from this project will be shared with local communities. Study plans and results of project /427 and project /273 have been presented in the oil spill communities of Tatitlek, Chenega Bay, Cordova, Port Graham, Nanwalek, and Seldovia and at

meetings of community facilitators. We will continue with this effort. Project staff has and will continue to present information to local communities or prepare articles or photographs for Trustee Council publications. Boat and air charter contracts, and other services will be contracted from local sources when possible.

PROJECT DESIGN

1. Surveys

A. Objectives

1. Compare population structure (number of breeding pairs, subadult males, adult males, and females) between oiled and unoiled areas during March.

2. Estimate density for oiled and unoiled survey sites in March.

3. Compare annual changes in density and population structure for oiled and unoiled survey sites.

4. Compare annual changes in density and population structure within oiled and unoiled survey sites

5. Compare results with EVOS project /427 Harlequin Duck Recovery Monitoring.

B. Methods

This study will test the following hypotheses:

1. Objective 1.
   H_o: The ratio of males to females; adult males to subadult males; and breeding pairs to total ducks is the same for oiled and unoiled populations during March.

   H_1: The ratio of males to females; adult males to subadult males; and breeding pairs to total ducks is different for oiled and unoiled populations during March.

A generalized logit model (Agresti, 1990) will be used to test differences in population structure for oiled versus unoiled survey sites for winter and spring. Male:female ratios for individual survey periods will be compared by estimating proportions using cluster sampling (flocks) (Cochran, 1977).

2. Objective 2. No hypothesis is being tested.

3. Objective 3.
   H_o: The rate and direction of population change between years is the same for oiled and unoiled survey sites.

H_1: The rate and direction of population change between years is different for oiled and unoiled survey sites.

Density changes will be tested by regression and population structure will be tested with logistic regression (Agresti, 1990).

4. Objective 4.

H_o: The rate and direction of population change between years is the same within oiled and unoiled survey sites.

H_1: The rate and direction of population change between years is different within oiled and unoiled survey sites.

Density changes will be tested by regression and population structure will be tested with logistic regression (Agresti, 1990).

4. Objective 5. No hypothesis is being tested.

Surveys will be conducted in representative portions of oiled areas in western PWS and unoiled areas in eastern PWS. FY 95-97 survey routes will be repeated (Rosenberg and Petrula 1997). Surveys will be conducted from approximately March 8 through 20. Repeat surveys will not be conducted and surveys in oiled and unoiled areas will not be conducted simultaneously because population flux is expected to be minimal at this time of year. New surveys will be established in areas with known concentrations of birds. All harlequin ducks will be recorded along each survey route. Observations will be recorded as pairs or by sex, and males will be divided into two age groups using predetermined criteria (Rosenberg and Petrula 1999.). Surveys will be conducted from open skiffs up to 20 feet long. Each skiff will have two observers. Surveys will be conducted from within 30 meters of shore along predetermined routes. A pace and course will be chosen that will assure complete coverage of the survey area and maximize the opportunity to see ducks. All transects will be mapped and all observations will be recorded by date and location and mapped by flock. Exxon Valdez oil spill beach segment modifiers (oiled areas), habitat associations, time, and weather will be noted.

Population composition and annual changes in density will be compared to test whether harlequin duck populations are exhibiting similar growth trends or the oiled (injured) population is exhibiting a different direction or rate of change. We will continue to test whether low reproductive success in oiled areas has resulted in changes in population age and sex structure. The proportion of first-year males to total males will be used as a measure of past reproductive success. Proportions of paired birds and male:female ratios will be compared for oiled and unoiled sites to indicate breeding propensity. Surveys will be used to detect changes in abundance and compare the direction and rate of change between years for the two survey areas. Surveys within oiled and unoiled areas will be compared to determine if geographic differences are detectable. Data from FY95-FY97 surveys will be incorporated into the analysis when applicable.

Sufficient power to test the hypotheses presented above (detecting a significant difference in slopes) is expected for this project based on the power generated from project \427, Harlequin Duck Recovery Monitoring (Rosenberg and Petrula 1998, in prep.). Using similar survey techniques and time frames that project was able to reject the null hypothesis (no difference in rate of population change between oiled and unoiled areas) with the following power:

Power at alpha = .05	**.80**
Power at alpha = .10	**.88**

2. Telemetry

A. Objectives

1. Capture and implant 10 adult males in the oiled areas of PWS with satellite transmitters.

2. Capture and mark with colored leg-bands as many other harlequins as time allows.

3. Map movements and distribution of telemetered birds. Identify pre-breeding movements within PWS, migration routes, breeding areas, post-breeding movements, and timing of movements.

B. Methods

Capture and Marking

ADF&G will capture, mark, and monitor harlequins with professional staff, veterinarians, and local assistance. We will capture 10 adult males in late March during the monitoring surveys. The capture, marking, and handling of birds will follow procedures of the Ornithological Council (1997). All birds will be captured in the oiled areas of PWS. A minimum of two sites will be selected. Proposed capture sites include Green Island, Foul Bay, Crafton Island, and Bay of Isles. Harlequin ducks will be captured with floating mist nets. Trap locations will be mapped using Global Positioning Systems and nautical charts (NOAA).

All captured ducks, in addition to those marked with telemetry, will be banded with USFWS aluminum leg bands and colored leg bands. Sex will be identified based on plumage characteristics and plumage and bursal probing will determine age. Adults lack a bursa. Prior to release, birds will be weighed, measured (culmen, tarsus, and wing length) and blood and feather samples will be collected and archived.

Once transported to the work vessel, a certified veterinarian, trained in avian implant surgeries, will place transmitters in the peritoneal cavity with the antenna exiting caudally, following procedures described by Petersen et al. (1995). Satellite transmitters will measure 10 mm deep, 55 mm long, 35 mm wide and weigh approximately 38 g. Battery life can be expected to last from 6 - 12 months depending on advances in technology at time of purchase. Each transmitter

will be hermetically sealed with a Teflon-coated multi-strand stainless-steel antenna. Transmitters will be programmed and calibrated to record and transmit body temperature to confirm that signals are being emitted from live birds. All ducks will be released at the point of capture. Duty cycles will be set to maximize transmissions from the time of capture to nesting, and be reduced once birds have returned to molting sites. All ducks will be released at the point of capture.

Satellite signals will be analyzed using Service Argos Data Collection and Location System (Landover, Maryland). Argos Standard and Animal-Tracking data processing services will provide near real-time information on the precision of each location through on-line interrogation. Movements will be monitored throughout the life of the transmitter. Locations will be mapped using a Geographic Information System (GIS).

No nesting studies are proposed in FY00.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

ADF&G personnel will conduct all data collection and analysis. Winter surveys, and contracts for vessel support for winter surveys, will be coordinated with related USGS-BRD sea duck projects and ADF&G project /273 (Scoter life history and ecology:linking satellite telemetry with traditional ecological knowledge) Private sector contracts for transmitters and winter vessel support will be solicited. At this time, only only one company manufactures transmitters.

SCHEDULE

A. Measurable Project Tasks for FY 00

October 1999	Project start-up. Interagency coordination. Plan logistics and personnel for winter surveys. Contract for vessel support and transmitters.
Jan. –Feb. 2000	Hire seasonal technicians, contract for veterinarian support. Prepare field equipment. Finalize field logistics.
March 2000	Conduct winter surveys and capture birds in PWS.
April – August 2000	Create databases, GIS. Analyze field data and begin report preparation.
April 2001	Annual Report submitted

B. Project Milestones and Endpoints

FY00

October-February:	Coordinate and plan surveys, order transmitters, prepare equipment, contract for vessel support, hire personnel.
March:	Conduct population surveys and capture birds for telemetry
April-September:	Data analysis and report preparation.
April 15:	Submit annual report.

FY01

October-February:	Coordinate and plan surveys, order transmitters, prepare equipment, contract for vessel support, hire personnel.
March:	Conduct population surveys and capture birds for telemetry
April-September:	Data analysis and report preparation.
April 15:	Submit annual report.

FY02

October-February:	Coordinate and plan surveys, order transmitters, prepare equipment, contract for vessel support, hire personnel.
March:	Conduct population surveys and capture birds for telemetry
April-September:	Data analysis and report preparation.
April 15:	Submit annual report.

This is a projected three-year monitoring program designed to assess the recovery of an injured species. Each project objective will be assessed annually for oiled and unoiled areas then compared with each other and with data collected in subsequent years. Year to year trends will first be compared in 2000 and then each year after. At the end of each year results will be compared with the restoration goals to assess whether recovery has occurred.

C. Completion Date

Under present guidelines, Harlequin ducks will have recovered when breeding- and nonbreeding-season densities return to prespill levels. An increasing population and decreasing exposure to hydrocarbons in oiled parts of PWS will indicate that recovery is underway (Exxon Valdez Oil Spill Trustee Council, 1999). This project will compare harlequin duck population structure and abundance between oiled and unoiled areas and within geographic areas. This study will be completed when oiled and unoiled populations exhibit similar structure and population trends (accounting for geographic differences) and the oiled population is no longer declining. Until further information is gathered it will not be possible to predict when densities will return to prespill and populations will exhibit a positive trend. This project may also discover new information that will suggest changes to the Recovery Objectives.

PUBLICATIONS AND REPORTS

Annual reports will be presented to the Chief Scientist by April 15. Reports will include survey areas, population structure and abundance and movements and timing of marked birds. A final report will be prepared at the end of the proposed monitoring schedule unless continued monitoring is warranted or when recovery objectives are met. Special reports (publications) will be prepared during the course of the monitoring effort if warranted. Publications will be prepared for peer-review journals when sufficient data has been collected to warrant manuscript preparation.

PROFESSIONAL CONFERENCES

Harlequin duck Working Group. Time and date to be determined.

NORMAL AGENCY MANAGEMENT

There are no other agency or non-agency contributions to this project. ADF&G is not required to conduct these surveys by statute or regulation. Limited staffing and funding precludes ADF&G from undertaking these surveys as part of normal operations and in the past ADF&G has not conducted marine bird surveys in PWS as part of its normal waterfowl management functions.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This research relies on incorporation of methods and information from other EVOS Trustee sponsored research, including projects /427, and /025. Equipment purchased by /427 will be used to conduct this research. Location of research sites, and data collection and analysis will follow previously established protocols. Equipment and logistics will be shared with project \273 Surf Scoter Life History and Ecology: Linking Satellite Telemetry with TEK to Conserve the Resource. All efforts will be made to coordinate surveys and share vessel support and equipment with USGS-BRD projects and project /273. Personnel with ADF&G and USGS-BRD will assist each other when possible.

This project will be integrated with ongoing studies or findings of past studies including project \273 Surf Scoter Life History and Ecology: Linking Satellite Telemetry with TEK to Conserve the Resource, \052B Traditional Ecological Knowledge; project \025 Nearshore Vertebrate Predator Project; project \427 Harlequin Duck Recovery Monitoring; and project \159 Prince William Sound Marine Bird and Mammal Surveys.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This is a new project.

PROPOSED PRINCIPAL INVESTIGATORS

Dan Rosenberg
Alaska Dept. of Fish and Game
333 Raspberry Road
Anchorage, Alaska 99518
(907) 267-2453
FAX: (907) 267-2433
danr@fishgame.state.ak.us

PERSONNEL QUALIFICATIONS

Dan Rosenberg has been a waterfowl biologist for The Alaska Department of Fish and Game (ADF&G) since 1985. From 1980-1983 Mr. Rosenberg conducted field research in Alaska as a waterfowl biologist for the U.S. Fish and Wildlife Service and from 1983-1984 as a Habitat Biologist for ADF&G. Mr. Rosenberg received a Bachelor of Science degree in Wildlife Management from Humboldt State University, Arcata, CA in 1979.

Mr. Rosenberg has conducted harlequin duck population (age and sex structure) and production surveys in Prince William Sound since 1994 as the Principle Investigator of a Trustee sponsored restoration project. Mr. Rosenberg is currently the principal investigator on EVOS Trustee sponsored project \273 Surf Scoter Life History and Ecology: Linking Satellite Telemetry with TEK to Conserve the Resource. He has conducted extensive waterfowl population monitoring and habitat assessment surveys on the Copper River delta, Stikine River delta, Kenai wetlands, upper Cook Inlet, Aleutian Islands, and Kodiak Island. As project leader, Mr. Rosenberg has assessed impacts to waterfowl and wildlife populations from hydroelectric development, urban expansion, habitat alterations, chemical pollutants, timber harvest, and surface mining.

OTHER KEY PERSONNEL

Mike Petrula, Wildlife Biologist, ADFG. Field logistics, surveys, data analysis, and report preparation. Mr. Petrula has an MS degree in wildlife Biology from the Univ. of Alaska, Fairbanks. He has been working on EVOS projects \427 Harlequin Duck Recovery Monitoring and \273 Surf Scoter and Goldeneye Life History and Ecology: Linking Satellite Telemetry with TEK to Conserve the Resource.

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2000 EXXON VALDEZ TR[redacted]EE COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$34.3
Travel		$1.5
Contractual		$36.3
Commodities		$30.3
Equipment		$0.0
Subtotal	$0.0	$102.4
General Administration		$7.7
Project Total	$0.0	$110.1
Full-time Equivalents (FTE)		0.6
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

		Estimated FY 2001	Estimated FY 2002		
		$110.0	$110.0		

Dollar amounts are shown in thousands of dollars.

Comments:
If this project and ADFG project 00273 (Scoter life history and ecology) are both funded, costs may be reduced by sharing some services in PWS.

FY00

Prepared:4/4/99

Project Number: 00407
Project Title: Harlequin Duck Population Dynamics and Satellite Telemetry
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

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

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
D. Rosenberg	WBIII, Principle Investigator	18J	2.2	6.5		14.3
Mike Petrula	WBII, survey and data analysis	16C	2.5	4.3		10.8
C. Barnhill	Cartographer II	16L	0.5	5.2		2.6
2 F&G Tech.	F&G Tech. III, Field Technician	11F	1.5	3.7	1.0	6.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		6.7	19.7	1.0	
					Personnel Total	$34.3

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
Portage-Whittier Alaska Railroad vehicle,boat, and 1 psng.	0.4	2			0.8
Portage-Whittier Alaska Railroad vehicle and psng.	0.1	2			0.2
Portage-Whittier Alaska Railroad Psg. fare	0.1	1			0.1
Per diem Whittier			4	0.1	0.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.5

FY00

Prepared:4/4/99

Project Number: 00407
Project Title: Harlequin Duck Population Dynamics and Satellite Telemetry
Agency: ADFG

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TR[redacted]EE COUNCIL PROJECT BUDGET
October 1, 199[redacted] - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
Boat and outboard motor repair and maintenance	1.0
Photo processing, presentation productions	0.4
Air charter for field support 4 hrs @ $270/hr	1.0
Trailer and boat moorage Whittier	0.1
Vessel support for bird capture and marking 14 days @1300/day	18.2
Veterinarian - surgical implants	3.0
Anaesthetist - surgical implants (anaesthesia)	1.6
Satellite Telemetry - Service Argos data processing - 10 birds at $900/bird	9.0
Cospass-Sarsat ground receiver rental $38.50/day x 45 days,insurance, shipping	2.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$36.3

Commodities Costs:	Proposed
Description	FY 2000
Boat fuel 300 galllons @ $1.50/gal	0.5
Boat supplies- replacement parts, props, fuel lines, fuel filters, water filters, battery, absorbent rags, oil, emergency provisions	0.8
Field survey supplies- rite-in-rain notebooks/paper, nautical charts, batteries,	0.3
Veterinary surgical supplies	0.6
Mist nets and trapping supplies	0.9
Colored tarsus bands 200 @$1.00/band	0.2
Satellite Transmitters - 10 @ $2700 each	27.0
Commodities Total	$30.3

FY00

Prepared:4/4/99

Project Number: 00407
Project Title: Harlequin Duck Population Dynamics and Satellite Telemetry
Agency: ADFG

FORM 3B
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 2000
NONE			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
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
20 ft. Caribe rigid hull inflatable	1	ADFG
17 ft. Boston Whaler	1	ADFG
10x40 binoculars	4	ADFG
Spotting Scopes	2	ADFG
Achilles 8 ft inflatable dinghy	2	ADFG
Remington Shotguns	2	ADFG
Survival Suits	2	ADFG
Outboard Motors/various hp	6	ADFG
Magellan GPS	3	ADFG
Marine VHF radios	4	ADFG

FY00

Prepared:4/4/99

Project Number: 00407
Project Title: Harlequin Duck Population Dynamics and Satellite Telemetry
Agency: ADFG

FORM 3B
Equipment
DETAIL

Assessment of Human Disturbance to Nesting Black Oystercatchers
(Haematopus bachmani)

Project Number:	00413
Restoration Category:	Research
Proposer:	Kenai Fjords National Park
Lead Trustee Agency:	DOI
Cooperating Agencies:	USFS
Alaska SeaLife Center:	No
Duration:	1st year; 1-year project
Cost FY00:	$ 46.2
Cost FY01:	$ TBD
Cost FY02:	$ 0
Geographic Area:	Prince William Sound and Kenai Fjords
Injured Resources/Service:	Black oystercatcher

ABSTRACT

This project will follow-up on work begun by (and funded by) the National Park Service in Kenai Fjords National Park in FY99. A controlled field study will be conducted to determine the impacts, if any, of recreational campers on the behavior of nesting black oystercatchers. Each selected nest will be observed in undisturbed, disturbed, and post-disturbed states and quantified behavioral observations will be compared. The pilot study being conducted at Kenai Fjords National Park, may dictate changes in the methods proposed here. The results of this research will directly effect how backcountry use in Kenai Fjords National Park and the Glacier Ranger District of the Chugach National Forest will be managed, and will be applicable to other coastal areas as well.

INTRODUCTION

This project is an expansion of a pilot project being implemented, and funded, by the National Park Service in Kenai Fjords National Park (KFNP) in FY99. It is anticipated that a larger sample size than can be attained along the Kenai Fjords coast will be needed to adequately test the research hypothesis. Western Prince William Sound (PWS) is an obvious choice in which to continue this effort due to the concern for black oystercatchers as a result of the *Exxon Valdez* Oil Spill (EVOS), large numbers of oystercatchers, and increasing levels of recreational use. A controlled field study will be conducted to determine the impacts, if any, of recreational activities on the behavior of nesting black oystercatchers. Each selected nest will be observed in undisturbed, disturbed, and post-disturbed states and quantified behavioral observations will be compared.

In general, shorebird species have been shown to be sensitive to human disturbance. Burger (1986) notes that although data are limited, shorebirds may be more sensitive than other waterbirds to human presence. Numerous cases of mammalian and human disturbances significantly affecting black oystercatchers (*Haematopus bachmani*) are cited by Andres (1995) in his description of that species.

There is spatial and temporal overlap between nesting black oystercatchers and backcountry visitors on the coast of KFNP and in PWS. Sea kayakers and power boaters prefer to land on protected sand, gravel or cobble beaches. Those same beaches offer prime nesting habitat for black oystercatchers. Andres (1998) reports that densities of breeding black oystercatchers in PWS are highest along shorelines with gradual slopes, which in most cases have sand, gravel or cobble substrate. In addition, most oystercatcher pairs use the same nesting territory for 3-5 years (Andres and Falxa, 1995).

There is also a temporal overlap between black oystercatchers and human activities. The breeding season for black oystercatchers in the north-central Gulf of Alaska is from mid-May to mid-July, and the peak time for recreational use is from mid-June to late August. Thus, most oystercatchers have already set up nests and laid eggs prior to the arrival of the campers who then intrude on their territories.

NEED FOR PROJECT

A. Statement of Problem

Human activity in PWS is expected to increase significantly in the next decade (ADOT 1995). Appropriate management of that activity by the USFS, Alaska DNR, and other land management agencies will be critical in protecting the natural resources of the area, particularly those resources already under stress as a result of the EVOS. As noted above, nesting shorebirds, including black oystercatchers, may be extremely sensitive to direct human disturbance. Humans also have a tendency to attract predators to nests, and thus their presence may also indirectly cause nesting failure. Predation may be another major factor influencing the productivity of nesting black oystercatchers in PWS and according to Andres (1998) may

contribute to local patterns of nesting distribution. The results of this project will provide crucial information that managers need in order to adequately protect black oystercatchers in areas of human activity. Results of this research will show if humans and oystercatchers can coexist on beaches, and if so, how far apart they must be. This information, in combination with the results from the human use and wildlife disturbance modeling project (99339), will provide a valuable tool to land managers in PWS to address increased human activity in the Sound.

B. Rationale/Link to Restoration

The Trustee Council has made significant progress in understanding the effects of the EVOS and in restoring and protecting the resources and services injured by the spill. However, the recovery of these resources and services may be affected by a dramatic increase in human use in PWS. The ADOT has predicted that the Whittier access road will result in an increase of over 600% in recreational and tourism boat traffic in parts of western PWS by the year 2015 (ADOT 1995). However, the Whittier road is one of several changes that will affect human use in PWS. For example, new cruise lines have incorporated Cordova onto their schedules and permits for float house businesses are increasing in eastern PWS. As more people recreate and work in PWS, there will be higher levels of interactions between people and injured resources, including black oystercatchers whose sensitivity has been noted above. Black oystercatchers in PWS are now showing signs of recovering from the effects of the oil spill. By investigating the potential effects of human activity on nesting oystercatchers, the Trustee Council will provide important management information to help ensure that recovery continues.

C. Location

This proposal expands the KFNP pilot project to include PWS. The project will benefit all State and Federal agencies with management responsibilities for coastline in the Gulf of Alaska and may be applicable to other regions where black oystercatchers breed.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Community involvement will be most important in the application of management strategies that result from this research. During the pilot project at KFNP, community volunteers are being used to create the "controlled disturbance" at test sites. Opportunities to include volunteers in the PWS project will also be investigated.

PROJECT DESIGN

A. Objectives

Assess changes in nesting behavior of black oystercatchers induced by human disturbance.

B. Methods

Null hypothesis: There is no difference in the behavior of nesting black oystercatchers between periods of no human disturbance, periods of human disturbance, and periods of post-disturbance.

The general methods to be used, as will be tested at KFNP in FY99, involves observing the behavior of pairs of nesting black oystercatchers for approximately 72 hours each: first in an undisturbed "natural" state, then with a controlled disturbance (i.e. people camping nearby), then in a post-disturbance state. These methods will be readjusted after the FY99 field season to refine the techniques.

1. Conduct a boat-based survey in mid-May to locate black oystercatcher nests in areas of concern (where recreational use occurs). Utilize existing information, if available, to help located nests. Based on the results of this inventory, select nests for observation.
2. A trained observer will unobtrusively make their way to an observation point that is hidden from the nesting birds, typically on a hillside above the beach, and set up an observation post using a spotting scope and binoculars to watch the nest.
3. The "undisturbed" nesting birds will be observed for approximately 24 hours noting environmental parameters and bird behavior (observations should last as long as possible including as much evening and morning time as is feasible due to daylight limitations).
4. At the same nest, a "controlled disturbance" will be introduced consisting of kayakers landing on the beach and camping for 24 hours. Nest observations will be continued throughout this period as noted above.
5. The kayakers will then leave and observation will be continued for another 24-hour post-disturbance period to see if behavior returns to a pre-disturbance character.

Nest Inventory

Survey team of two to three members will cruise the shoreline in small boats travelling at 5-10 knots looking for adult black oystercatchers. If behavior that indicates nesting is observed, the team will go ashore and search for the nest. All occurrences of adult oystercatchers, nesting or not, will be recorded. As is feasible, beaches will be walked from end-to-end looking for adult birds and nests. When a nest is found, information on nest location and descriptive information will be collected according to protocols provided.

Behavioral Observations

Data will be collected that describes the behavior of the birds, the nature and level of disturbance, and environmental factors effecting the study site. Behavior and disturbance will be recorded as categories. The behavioral categories will be defined during the pilot study. The disturbance categories are at this time defined as follows:

1. No disturbance - now or within the last 24 hours
2. Approach – coming into cove or beach
3. Landing – kayakers landing
4. Unloading – unloading boat and shuttling gear
5. Setting up – setting up camp, moving around

6. In camp – sitting around camp, little noise or movement, possibly cooking
7. Sleeping – in tents, quiet
8. Breaking camp – packing up, moving around
9. Loading – carrying gear down to boats
10. Launching – kayakers leaving beach
11. Leaving – leaving cove
12. Post disturbance – within 24 hours of camping

Environmental variables that may affect nesting behavior, such as tide level and time of day, will be compensated for by using a 24-hour observation period for each level of disturbance. Other factors such as weather and uncontrolled disturbance will need to be adjusted for in the field by adding additional observation time at a particular nest if necessary.

The following "controlled disturbance" parameters will be kept constant throughout the study:

1. Number of people - two or three people in the camping group causing the "disturbance".
2. Distance of campsite from nest - to start with, the distance will be set at 100 meters. Landing and camping will take place at that distance.
3. Line of sight from nest - camping will be line-of-sight from the nest when possible.
4. Number of tents – one or two tents of consistent color and size.
5. Level of noise – kept as consistent as possible between sites.
6. Campers walking toward nest - this will be avoided, at least during the pilot study. This may be tested in FY00, depending on the results from FY99.
7. Types of camper activity – will be kept as consistent as possible in terms of activities and timing.

It is anticipated that comparisons between nests will not be feasible due to anticipated high levels of variance in behavior between nesting pairs. The parameter that will be tested is the amount of change between undisturbed, disturbed, and post-disturbed behavior at each nest.

Three days of observation will be required per nest. Allowing for uncontrollable circumstances and moving between sites, four days per nest should be scheduled. Given an approximate breeding period of 30 days, one team will be able to sample between 7 and 10 nests during a single season. Thus a combination of the pilot study and the additional year being proposed here will provide a sample of 14 to 20 nests, with a total of 336 to 480 hours of observation time in each disturbance category.

The primary alternative method that was considered was to look at overall success of black oystercatcher nests in disturbed versus undisturbed areas. Several problems were apparent with this approach including: the large number of nests needed and the cost to monitor that many nests, controlling or monitoring the level of disturbance, the unknown prior history of

disturbance at each nest (some pairs may be habituated to human presence), the environmental variation within the study area.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The cooperating agencies on this project are DOI (KFNP) and USFS (Chugach National Forest). KFNP is funding and conducting the pilot study in FY99. Because the results are extremely valuable and applicable to USFS management goals in PWS, the two agencies are working jointly on this project. In FY00 the fieldwork will take place in PWS and will be conducted primarily by the USFS, although KFNP will be the lead agency on the project, continuing the FY99 pilot study and increasing the sample size by expanding the project into similar habitats in PWS. KFNP will provide project oversight in terms of training and methods, and will also provide vessel support of the nest inventory portion of the project. The USFWS has also been an important partner in the development of protocols and methods by providing technical support and expertise.

SCHEDULE

A. Measurable Project Tasks for FY00

December 31:	Complete analysis of data and reports from FY99 pilot study
April (date to be set):	Present results of pilot study at NPS Alaska Region Natural Resources Conference
May 10-20:	Conduct nest inventory
May 21-June 30:	Conduct behavioral study at selected nests
July 1 – September 30:	Analyze results and prepare final reports

B. Project Milestones and Endpoints

The objective described in this proposal will be fully completed at the end of the project in September 2000 if a large enough sample size has been obtained to evaluate potential disturbance.

See measurable project tasks for FY00 listed above for specific milestones.

C. Completion Date

This project will be completed by September 30, 2000 if an adequate sample size has been obtained.

PUBLICATIONS AND REPORTS

The final report for this project will be submitted to the Trustee Council in April 2001. A manuscript will be prepared for journal publication in the Journal of Field Ornithology in FY00.

It is anticipated that additional manuscripts will be submitted for publication in other peer-reviewed journals at a later date.

PROFESSIONAL CONFERENCES

The principal investigators will attend the annual Restoration Workshop in FY00. Also, a KFNP representative will present the pilot project at the NPS Alaska Region Natural Resources Conference in April 2000.

NORMAL AGENCY MANAGEMENT

This project is outside of the scope of normal agency management for the Forest Service. While the agency shares concerns about shoreline nesting birds, this type of study is unlikely to be funded through the normal agency budget process. This project represents a cooperative effort by the Forest Service to assist the National Park Service in conducting research that has the potential to greatly benefit both agencies. The implementation of a project in PWS is also outside of the normal agency management for the National Park Service (due to jurisdictional boundaries). The National Park Service will continue to fund efforts related to this proposal in Kenai Fjords National Park as part of its normal agency management.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project is the result of coordination between the two key land management agencies that manage recreational use in the spill-effected area. The two principal investigators are dissolving political boundaries and committing time and personnel in each other's legislative jurisdiction in order to take an ecosystem approach to this issue. In addition, technical assistance is being provided by Brad Andres of the USFWS who has published several papers on black oystercatchers in PWS and was the principal investigator for the initial studies to evaluate injuries from the oil spill. The USFWS is also providing personnel to participate in the pilot study at KFNP. The results of this project, in combination with the results from the human use and wildlife disturbance modeling project (99339), will provide a valuable tool to land managers in PWS to evaluate the potential effects of increased human activity in the Sound.

PROPOSED PRINCIPAL INVESTIGATORS

Karen A. Murphy
Chugach National Forest
3301 C Street Ste 300
Anchorage, AK 99503
(907) 271-2286
(907) 271-3992(FAX)

Michael D. Tetreau
Kenai Fjords National Park
P.O. Box 1727
Seward, AK 99664
(907) 224-2112
(907) 224-2144 (FAX)
mike_tetreau@nps.gov

PRINCIPAL INVESTIGATORS

Michael D. Tetreau

Michael Tetreau received a Bachelor of Science in Wildlife and Wildland Recreation Management from Washington State University in 1988. His emphasis and senior studies were in human recreational impacts on vegetation and wildlife. Michael has worked at KFNP since 1987 and has been a Resource Management Specialist there since 1992 after graduating from the NPS Resource Management Trainee program. He worked extensively on the EVOS including several years of follow-up work monitoring the effects of the spill. Since 1991 Michael has supervised coastal field teams of biologists and rangers at KFNP and has supervised and participated in numerous field studies involving a wide range of natural resources. His extensive experience with coastal resources at KFNP and the EVOS, along with his numerous connections to other resource managers in coastal Alaska, have led him to be a principal investigator on this project. Michael will be responsible for conducting the pilot study, overseeing the entire project, and coordinating the development of methods and protocols. He will co-author the final project reports with the other principal investigator.

Karen A. Murphy

Karen Murphy received a Masters in Environmental Management from Duke University in 1995. Her thesis emphasis was on applying decision theory and risk assessment to wildlife management. Karen has extensive experience with fish and wildlife management on the Chugach National Forest. She began working in Alaska in 1984 as a biological technician responsible for conducting field surveys and monitoring in PWS, Copper River Delta and other areas of the Chugach National Forest. In 1991, she began working with the EVOS Restoration Planning Work Group. She participated in the development of the EVOS Restoration Plan and companion EIS. Since 1996, Karen has been the wildlife biologist for the Glacier Ranger District which covers western PWS and Turnagain Arm. Her current position, combined with her EVOS experience will enhance the opportunity to integrate this project with other EVOS projects and to apply the results to wildlife management on the Chugach National Forest. Karen will have primary responsibility for administering and coordinating this project and for the development of management recommendations.

OTHER KEY PERSONNEL

Brad Andres, biologist with USFWS. Brad has provided a great deal of technical assistance in formulating methods and protocols.

Declan Troy, private avian biologist and consultant. He has also provided invaluable information on study designs and methods.

LITERATURE CITED

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Andres, B. A. 1998. Shoreline habitat use of Black Oystercatchers breeding in Prince William Sound, Alaska. Journal of Field Ornithology. Vol. 69 *In press.*

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2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000	PROPOSED FY 2000 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
						$28.3	$17.9	
Personnel	$0.0	$31.2						
Travel	$0.0	$0.0						
Contractual	$0.0	$6.6						
Commodities	$0.0	$3.2						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$41.0			Estimated FY 2001	Estimated FY 2002		
General Administration	$0.0	$5.2						
Project Total	$0.0	$46.2				$0.0		
Full-time Equivalents (FTE)	0.0	0.7						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0			$0.0	$0.0		

Comments:

00413

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

FY00

Prepared:

Project Number: 00xxx
Project Title: Assessment of Human Disturbance to Nesting Black Oystercatchers
Lead Agency: National Park Service

FORM 2A
MULTI-TRUSTEE
AGENCY SUMMARY

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$9.4
Travel		$0.0
Contractual		$6.6
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$16.0
General Administration		$1.9
Project Total	$0.0	$17.9
Full-time Equivalents (FTE)		0.2
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		

Dollar amounts are shown in thousands of dollars.

Comments:

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

FY00

Prepared:

Project Number: 00xxx
Project Title: Assessment of Human Disturbance to Nesting Black Oystercatchers
Agency: National Park Service

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
						0.0
Mike Tetreau	Resource Management Specialist	GS11	1.5	5.3		8.0
unknown	Biological Technician	GS7	0.5	2.8		1.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.0	8.1	0.0	
					Personnel Total	$9.4

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
					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

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

FY00

Prepared:

Project Number: 00xxx
Project Title: Assessment of Human Disturbance to Nesting Black Oystercatchers
Agency: National Park Service

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:		Proposed FY 2000
Description		
Charter the Serac (National Park Service Boat)	1.5 weeks	5.3
Charter airplane Seward - PrinceWilliam Sound (RT)	$250/hour for 5 hours = $1300	1.3
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$6.6

Commodities Costs:	Proposed FY 2000
Description	
Commodities Total	$0.0

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

FY00

Prepared:

Project Number:00xxx
Project Title: Assessment of Human Disturbance to Nesting Black Oystercatchers
Agency: National Park Service

FORM 3B
Contractual & Commodities DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
			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

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

FY00

Project Number: 00xxx
Project Title: Assessment of Human Disturbance to Nesting Black Oystercatchers
Agency: U.S. Forest Service

FORM 3B
Equipment
DETAIL

Prepared:

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$21.8
Travel		$0.0
Contractual		$0.0
Commodities		$3.2
Equipment		$0.0
Subtotal	$0.0	$25.0
General Administration		$3.3
Project Total	$0.0	$28.3
Full-time Equivalents (FTE)		0.5
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		

Dollar amounts are shown in thousands of dollars.

Comments:

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

FY00

Prepared:

Project Number: 00xxx
Project Title: Assessment of Human Disturbance to Nesting Black Oystercatchers
Agency: US Forest Service

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
						0.0
Karen Murphy	Wildlife Biologist	GS11	0.5	5.3		2.7
JoEllen Lottsfeldt	Biological Technician	GS7	2.0	3.8	1.0	8.6
Unknown	Biological Technician	GS7	2.0	2.8	0.5	6.1
unknown	Recreation technicians	GS5	1.0	2.2		2.2
Unknown	Recreation technicians	GS5	1.0	2.2		2.2
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		6.5	16.3	1.5	
					Personnel Total	$21.8

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

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

FY00

Prepared:

Project Number: 00xxx
Project Title: Assessment of Human Disturbance to Nesting Black Oystercatchers
Agency: US Forest Service

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:		Proposed FY 2000
Description		
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$0.0

Commodities Costs:		Proposed FY 2000
Description		
miscellaneous expenses for camping supplies		1.0
Field per diem @ $18/day for 4 people for 30 days	2160	2.2
Use of field work boats from the Glacier Ranger District will be donated, this donations = $200/day for approx. 15 days or $3.0K		
	Commodities Total	$3.2

2000 EXXON VALDEZ TRUS' :OUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

FY00

Prepared:

Project Number: 00xxx
Project Title: Assessment of Human Disturbance to Nesting Black Oystercatchers
Agency: US Forest Service

FORM 3B
Contractual & Commodities DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
			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

Lessons from the *Exxon Valdez*: Using Interactive Information Displays to Engage the Public

(Submitted Under the BAA)

Project Number:	00414-BAA
Restoration Category:	Research and Monitoring (Ecosystem Synthesis)
Proposers:	Jennifer R. Allen
Lead Trustee Agency:	NOAA
Alaska SeaLife Center	yes
Duration:	1 year
Cost FY 00	$154 K
Geographic Area:	Spill-Affected Area

ABSTRACT

Ten years after the *Exxon Valdez* Oil Spill there exists a compelling need for translation and communication of accumulated scientific results to stakeholders. Interactive multimedia is a powerful communications tool that offers expanded possibilities for information transfer and user satisfaction. This project will establish interactive multimedia displays for the general public at three locations in the spill-affected area, including the Alaska SeaLife Center in Seward and the Prince William Sound Science Center in Cordova. The displays will present highlights from the restoration research projects with emphasis on ecosystem synthesis, using an appealing, understandable and entertaining format. Content will be developed in collaboration with EVOSTC investigators and the overall product is subject to review and approval by the EVOSTC office. In addition, this project will collaborate with Drs. Rice, Heintz and Short to produce a 30 minute, graphically oriented computer presentation to be used for disseminating the Auke Bay toxicity work to a wide audience.

INTRODUCTION

The Disaster . . .

The *Exxon Valdez* oil spill was a tragedy of indescribable proportions. Its impacts on the environment, wildlife and people of the region are still evident: eight species have shown little or no improvement since their spill injuries; ten species, plus intertidal systems, sediments and archaeological resources, are not fully recovered from the damage. In addition, a high human cost is still being borne by the people who make their living and their lives on and around the spill-affected waters. The human services of subsistence, commercial fishing, recreation/tourism, and passive uses are classified as still recovering, 10 years after the spill (EVOSTC, 1999). Today, as these affected people are slowly rebuilding, many are still searching for understanding, and most are hungry for knowledge about the spill.

The Opportunity . . .

One, perhaps the only, positive aspect to the disaster is the unprecedented scientific knowledge that has been gained in its wake. The spill-affected area has become one of the most thoroughly studied ecosystems in the world. Over $108 million has been invested to date in research and monitoring projects in a wide-ranging and comprehensive scientific program. Scores of individual projects have helped define the status of injured resources, understand mechanisms of injury, and track recovery. Three large scale, multidisciplinary, ecosystem-level investigations have dramatically increased our understanding of how the ecosystem works and what factors may be constraining recovery.

The Challenge . . .

For practical purposes, however, all the new knowledge is useful only if it can be accessed and understood. An immediate barrier arises from the fact that scientific products are delivered to other scientists in a way that makes them virtually unintelligible to "regular people", a fact which frequently incites understandable frustration among regular people who are trying to understand what is going on. It is unarguable that there now exists an immense and compelling need for translation and communication of accumulated scientific results to stakeholders.

It is important to ensure knowledge transfer not just to resource managers and specialists, but also to members of the public at large, since these are the people who need to be informed voters, advocates and participants in the planning processes that govern the region's resources. It is equally important to establish channels of communication via which technical research results can be transferred with meaning and context, and via which results and data can continue to be accessed into the future.

What is already being done?

The *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) has made information delivery a priority. In addition to its annual public workshop, printed quarterly updates, annual status reports, and library of project final reports, the EVOSTC office offers a bibliography of peer reviewed publications, a basic information database on 1992-96 projects on CD-ROM in FileMaker Pro, and a GIS database on CD-ROM in ArcView. The EVOSTC has also funded creation of an excellent set of written narratives organized by species and designed for lay readers (the *Restoration Notebook* series); and has supported the design phase of an integrated data management system for the Cook Inlet watershed, the plan of which includes accommodations for serving information needs of the general public. The EVOSTC web site provides entry to either access or locate all of the above information products.

The EVOSTC has also recently supported this investigator in production of graphical presentations related to the SEA program, via project 99361. This work makes use of advanced visual communications techniques and its results have been well received by wide audiences. A related videotape on the SEA program is currently in development, also funded under project 99361; this production has much reduced technical emphasis and will serve a lay audience via VHS video and possibly television.

In the first group of projects listed above, the communications methods used fall mainly into two categories: either a strong dependence on written/printed materials, or emphasis on delivery of spatial data via specialized mapping software. Each approach serves an important and needed function. The work of project 99361 has added another, complementary, dimension: use of dynamic visualization and presentation techniques to communicate complex concepts in an understandable way, focusing thus far on results from the SEA program. The new project proposed here will build on the achievements of project 99361, by (1) extending those techniques beyond SEA to wider syntheses of EVOSTC research findings, and (2) adding the technology of distributed interactive multimedia.

Why would Interactive Multimedia help?

One of the biggest challenges in translating science for general audiences is to *simplify enough that the material is easily understandable, but not so much that inaccurate perceptions are created.* This is a difficult undertaking, perhaps one reason why scientists often shy away from the task. Using traditional techniques alone, it is quite difficult to bridge the gap intermediate between a superficial, journalist-level representation of the results on the one hand and the scientist's own delivery of the results, with all the caveats, qualifiers and context therein entailed, on the other. For the most part, this intermediate area remains unserved, yet it is exactly that level of information which is being requested increasingly by the public. The astonishing public response to small pilot efforts within the SEA program has raised our awareness to the extent of this need. These efforts have also provided evidence for the value of multimedia applications in addressing the need.

Multimedia is the combination of varied elements, including text, sound, graphics, images, animation and motion video, into a cohesive communications vehicle. As the sidebar suggests, multimedia requires extra time and extra equipment, but offers a unique communications capability.

Perspectives

"We define multimedia as anything that takes more than two trips to the car" (Robert May, President, Ikonic Inc.)

"You have to have a real yearning to communicate because multimedia is, essentially, an entirely new syntax for communication" (Tay Vaughan, 1998)

Communications Power: Picture-oriented display techniques provide a powerful communication tool because they take advantage of the highly developed information processing/comprehension abilities of the human visual system (Gershon, 1994). Graphical displays enables "high bandwidth" information transfer and can enhance comprehension through intuitive illustration of concepts and complex relationships. Addition of time-based media (motion and sound) opens up further possibilities. Especially useful to us are the capabilities for progressive visual unfolding of information, animation of changes over time, and augmentation of visual imagery by narrative, music and sounds. Further, multimedia yields measurable benefit through its ability to gain and hold attention and interest. Presentation of information via multiple modalities including visuals, sound, and motion, has been shown to improve retention rates, learning speed, attention levels, credibility and overall impact of presentations (Lindstrom, 1994; Vaughan, 1998).

Interactive multimedia is distinguished by non-linear organization of content and active control by the user over what is seen (in contrast to the linear organization and passive viewing associated with live presentations and movies.). A considerable body of education and psychology theory exists to support the belief that interactivity enhances information transfer (reviewed by Wilson, 1993). Interactive multimedia is seen as "allowing users to follow their own associationist paths, to experiment and build their own cognitive structures, and to link their actions with internal...needs" (Wilson, 1993). From a practical standpoint, many of the benefits of interactivity are related to improved retention, relevance, access and motivation.

Retention: "Active learning" is associated with increased retention. User satisfaction is influenced by the sense of having understood and retained important new concepts. Instruction delivered by interactive multimedia can increase retention rate up to 3-fold over use of audio stimulation alone, and it doubles retention above that achieved with audiovisual stimulation but no interactivity (summarized by Lindstrom, 1994). This differential benefit of active learning has been likened to the difference between two people traveling together in a car to an unfamiliar location, one being the driver and the other a passive passenger -- the driver is more likely than the passenger to be able to find the way back to the location again at a later date.

Relevance: Interactivity increases the chance that information received will be relevant to a user's interest, not only because the user chooses the topics displayed, but also because the interactive structure allows hierarchical delivery of information. This means that progressive levels of complexity can be accessed on command, according to the user's interest, but all details need not be shown to every user. This helps shield the user from information overload, as might occur in a printed publication at similar depth, but yet makes in-depth, context-sensitive detail available as needed. User satisfaction is influenced both by the perceived pertinence of the information and the perceived sense of boundlessness of information available for the asking.

Information Access: The above concepts of electronic "information on demand" are currently fueling the web-based information revolution. The web itself is one specialized example of interactive multimedia. True multimedia (full screen video, CD-quality audio, fast-paced interactivity) via the web, however, remains an impossibility for the foreseeable future, particularly in Alaska, due to bandwidth constraints. In addition, citizens with personal internet connectivity, although rapidly growing in number, are still not a majority. Distributing multimedia to physical sites in public locations is a way of circumventing these limitations. Distributed interactive multimedia serves a broad spectrum of citizens by providing fast, simple access to rich, high-bandwidth content, without requiring a personal internet connection. Ideally it optimizes access by placing the delivery points at locations where it is likely that people will be seeking information. The empowering effect of self-paced interactive information access at this type of delivery point has been recognized and has led to wide deployment of multimedia terminals in a number of disciplines (see below).

Motivation: Stimulation of users to engage in the knowledge transfer process follows from the fun and entertainment value of the experience as well as the quality of the information received. Motivation is likely to be further enhanced by the benefits of interactivity just described: access, relevance, control/empowerment, and freedom to form knowledge linkages that address immediate needs of the individual.

Kiosks are standalone terminals that provide public access to information. By definition, they deliver interactive multimedia. The multimedia content may be stored on local devices (hard disk, CDi, CD-ROM) or accessed over a network. Display is usually by means of a video screen, and user control is typically via touch-sensitive input devices. Despite the advanced technology involved in creating a kiosk, a key defining feature is that they are *designed to serve users with little or no computer experience*. One familiar example of application of this technology is the museum kiosk. These structures are widely used today in museums to guide patrons through exhibits, locate information of interest, and provide in-depth supporting multi-sensory details about selected displays (Platten, 1998; Vaughan, 1998).

The Michigan medical kiosk outreach project is an example of use of this technology for large-scale information distribution (Strecher, 1997). In 1996, this $1 million project deployed 50 kiosks, each networked to a central database, around the state of Michigan for purposes of disseminating motivational preventive healthcare information on subjects such as

breast cancer and smoking. The kiosks were television-like and user-friendly, employing touch-screen technology to allow users to explore health information. Located in places highly accessible to the public, the kiosks used interactive multimedia to deliver custom-tailored health messages via a mix of digitized video and audio, text, animation, and still graphics. This study found no reluctance among citizens to use the kiosks, and attributed this to the kiosk design: inviting and unintimidating appearance, attractive eye-catching environmental graphics and rich stereo sound environment connecting the user with the on-screen visual imagery. Allowing individuals to create their own experiences through a hands-on interactive process improved comprehension and retention of information. Users were also more likely to take action based on the information they received. Reported satisfaction level of users was high, and in general users reported the system to be more useful to them than pamphlets and booklets. Satisfaction levels were greater for males than females, and greater for people under 50 years of age than over; however neither usage rate nor satisfaction rate was found to differ by ethnic group or education level (Strecher, 1997).

What are Potential Limitations/Problems of Interactive Multimedia?

Potential limitations and problems of distributed interactive multimedia include:

1. Unfamiliarity with computers or general apprehension about technology, particularly among some older users -- this may impede or discourage approach to the system.
2. Failure of the user interface to be adequately friendly, simple, obvious, and easy to use without instructions -- this is the most common and serious problem; if present it will cause user frustration, confusion, and kiosk abandonment (Platten *et al.*, 1998)
3. Poor organization and/or quality of content -- this may result in less satisfied users and risk of distributing erroneous information or ideas.
4. Poor artistic design -- will limit the esthetic experience for users and may reduce the number of people served.
5. Technical under-specification of the system – poor quality monitors with small cramped screens will compromise the effectiveness of the multimedia experience; likewise insufficient computer horsepower can make complex rendering unsatisfactorily slow.
6. The "queue factor"(Cooper, 1995) -- can occur if the system is too appealing and becomes monopolized by one user, or if demand is too high; the consequence is frustration for waiting users. A related problem also mentioned by Cooper can arise if the interface itself is too much fun or too gimmicky, giving rise to excessive button pushing just to "see what happens". Although probably not the worst problem to have, this effect would presumably interfere with the knowledge transfer process.
7. System breakdown, hardware malfunction, power failures, vandalism.

Plans for addressing these concerns are covered in the Methods section.

What Makes "Good" Interactive Multimedia?

Beyond the obvious imperative for appropriate and high quality content, the most critical aspect to the success of interactive multimedia is the interface design. Interface design for interactive multimedia is a field no longer in its infancy; a body of design theory and experience exists. The key tenets center on clarity and predictability, with secondary factors including intrigue, appeal and engagement. Many of the interface guidelines now advocated for multimedia have their roots in the graphical user interface theory pioneered at Xerox PARC in the 1960's, extended by Apple for their desktop computer interface and later adapted by Microsoft into the Windows system. It is difficult to improve on the original design guidelines laid out by the pioneering Apple developers in the early 1980's. These are excerpted below (modified slightly from Cooper, 1993).

User Interface Design Philosophy
(excerpted from the Apple Interface Guidelines)

- Metaphors are concrete and obvious. Audio and visual effects support the metaphor.
- Aesthetic integrity is maintained. Different "things" look different on the screen, similar "things" look the same.
- The computer environment remains understandable and familiar.
- Users feel they are in charge of the computer.
- The user, not the computer, initiates and controls all actions.
- Users select actions from alternatives presented on screen.
- Users are kept informed and given immediate feedback.
- A given user action always has the same result irrespective of past activities.
- The user's actions are generally reversible, the user is warned if not.
- The user should be able to do anything at any time.
- A way out is always provided.

What will this project do?

1.....Kiosks

- This project will establish interactive multimedia kiosks at three locations in the spill-affected area: the Alaska SeaLife Center in Seward, the Prince William Sound Science Center in Cordova, and one location to be named in Anchorage.
- The displays will feature highlights from EVOSTC-funded restoration research projects, with emphasis on ecosystem processes and across-project synthesis. Content will take the form of 3 to 5 minute vignettes on selected research results and conclusions, arranged by topic, and presented in a question-driven format.
- The displays will be designed to serve the general public and will present information in a format that is appealing, understandable, useful and entertaining.
- Content will be developed in close consultation with participating EVOSTC investigators. Decisions regarding overall design and artistic content will be made in collaboration with the EVOSTC communications director. During development, multiple opportunities will exist for review by EVOSTC staff and/or the Chief Scientist. The EVOSTC Director will have final approval authority over all interactive programs.

2.....Selected Long Program

- One topic from the EVOSTC research program has been selected as the subject of an extended (30 minute) production. The selected topic is the toxicity work of Drs. Rice, Heinz and Short from the Auke Bay Laboratory. If the proposed multimedia project is funded, the Auke Bay group has kindly agreed collaborate with Dr. Allen in production of a multimedia presentation on their ground-breaking findings. This production will be targeted to a general audience and will be suitable for live delivery or distribution on CD-ROM.. A condensed version of this program will be featured as one of the kiosk vignettes.

NEED FOR THE PROJECT

A. Statement of the Problem

What is the problem to be addressed? Which injured resource or service is it designed restore?

In order for the goals and value of EVOSTC-funded restoration research to be fully realized, it is important that new knowledge be disseminated to stakeholders and decision makers. Knowledge transfer is an important step in ensuring a more informed basis for restoration activities, resource management and design of future long-term monitoring plans. The task of communicating complex scientific results to a non-specialist audience, however, is challenging.

B. Rationale/Link to Restoration

Why should the work be done? Discuss how the project will address the problem.

The work proposed here will assist in communicating to the general public the new understanding that has resulted from EVOSTC research programs. Distributed interactive multimedia will provide an effective vehicle for wider knowledge transfer by illuminating difficult concepts and delivering needed information in an accessible, engaging, useful and entertaining manner. Successful completion of this work will assist the Trustee Council and the public "to view the effects of the oil spill and the long-term restoration management of injured resources and services from broad, multi-project and ecosystem-level perspectives. Having the benefit of these perspectives will not only aid interpretation of past results in regard to injury and recovery, but will also provide an improved framework for development of long-term restoration, research, monitoring and management plans." (EVOSTC, 1999b).

C. Location

Where will the work be done? Where will its benefits be realized?

The work will be performed at the Prince William Sound Science Center in Cordova; the SeaLife Center in Seward, and the Auke Bay Laboratory, Juneau. Benefits will be realized throughout the spill-affected area.

COMMUNITY INVOLVEMENT

How will affected communities be informed of the project and provide their input?

Affected communities will be informed of the existence and progress of the project, and may provide input, via a new dedicated web site that will be created and maintained by the principal investigator. Upon opening, the exhibits will be publicized via local newspaper and radio announcements. Users of the public displays will be invited to give feedback and suggestions via online forms and written comment cards.

A. Objectives

The objective of this project for FY00 are:

1. To develop detailed specifications for the most cost-effective hardware combinations available today for delivery of high quality interactive multimedia displays via standalone kiosks.
2. To create software content for an interactive multimedia display featuring selected highlights of EVOSTC funded research, with emphasis on cross-project synthesis and ecosystem-level conclusions, at a level suitable for the general public, with a user interface that requires no previous computer experience, in a format which is both appealing and informative.
3. To configure and deploy displays at three public locations in the spill-affected area: the SeaLife Center in Seward, the PWSSC in Cordova, and a site to be named in Anchorage.
4. In collaboration with Drs. Rice, Heintz, and Short: To produce a 30 minute dynamic graphical presentation to assist in wider dissemination of the EVOSTC-funded Auke Bay toxicity studies.

B. Methods

I. General Considerations

1. The hardware costs shown in the attached budget are mid-range estimates. They are based on a preliminary survey of technical/trade literature/web-sites performed by this investigator, plus a needs analysis consultation performed by Presentation Products, Inc. (Anchorage and Santa Fe offices), in early April, 1999. Given the exponential rate of advancement in this technology sector it is likely that prices may be lower, and/or capability greater, by the start date of this project.
2. Because of consideration #1, if this project is funded an initial period of one calendar month will be devoted to researching the latest hardware options and developing bid specifications. The goal is to ensure that this project delivers the most current and cost-effective hardware configuration possible within the constraint of adequate quality.
3. This investigator is mindful of the responsibility involved in presenting to the public the research results of other scientists. This responsibility is not taken lightly. A commitment is made to work closely with participating EVOSTC investigators. Segments will not be considered complete until the originator of the research is fully satisfied with the representation. In addition, the EVOSTC Science Advisor, and/or Chief Scientist, or their designees, will have opportunities for review and approval of both storyboard and final content (see Workflow).

4. The EVOSTC office has a well equipped and expertly staffed communications office which has been responsible for a number of outstanding audio-visual and print productions. It is not the intent of this project to duplicate existing functions. Rather, it is hoped that this project will augment existing efforts by offering some additional expertise in the specialty of computer-based presentations. It will be the intent and wish of this investigator to foster a close collaboration with the EVOSTC communications office, including free sharing of media and concepts. A major goal will be to avoid any duplicative effort, maximize use of existing resources, and obtain a synergistic shared result.

II. Hardware

Figure 1 shows the components of the proposed multimedia kiosks, in schematic form.

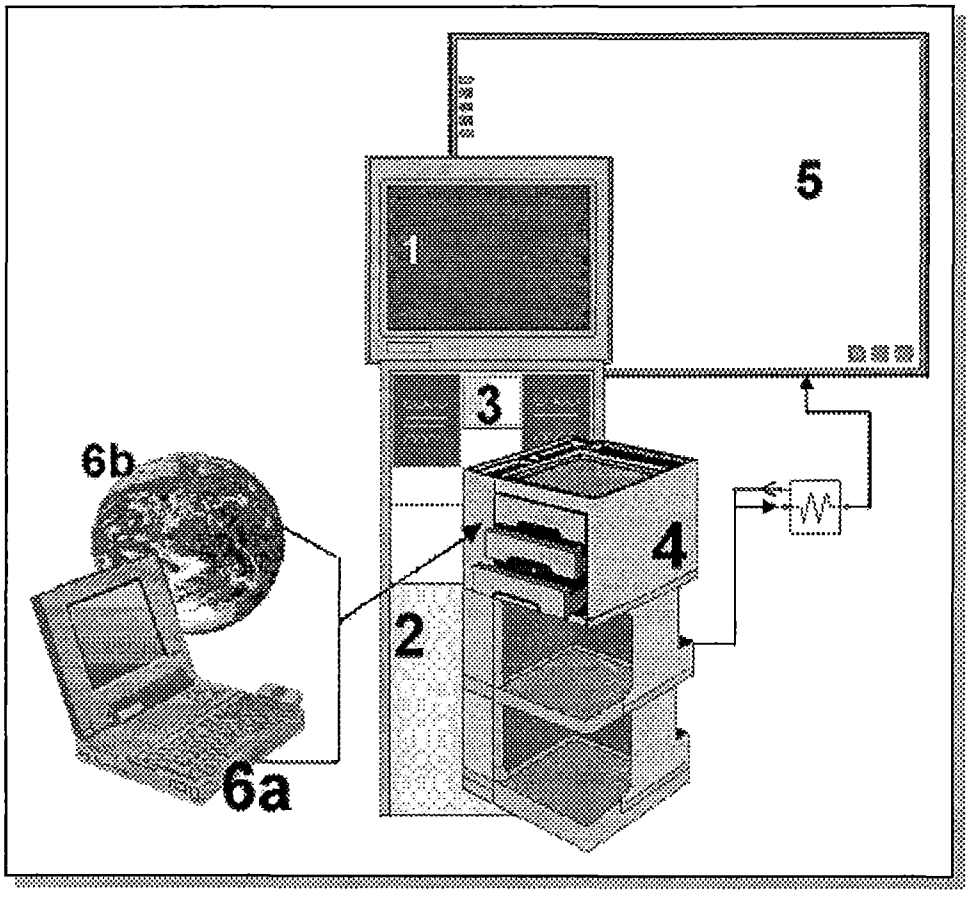

Figure 1: Schematic of kiosk components
1- Touch screen 2- Kiosk cabinet 3- Speakers
4- Internal structure of cabinet (illustrated with cabinet housing removed). Assembly provides mounts for computer CPU, disk drives, power supply and other equipment.
5- Large wall-mounted electronic board for group display
6- Methods of updating content.
6a: via direct file transfer from laptop or CD
6b: via Internet (future extension, not in current configuration).

The key components are :

- An external enclosure/cabinet - contains and protects the computer components. Should be movable but able to be secured to a floor mount. Secure closure and robust design, convenient access to inner components for servicing. Sleek modern exterior style. Figure 2 shows some current examples of kiosk design; cabinet, wedge, pedestal and wall-mount configurations are illustrated.
- A video monitor and touch screen interface - Monitor is high quality minimum 17-21" XGA resolution; touch screen uses capacitive technology or better and has glass overcoat to seal and protect the sensor surface.
- Computer assembly - Intel pentiumII-based CPU with MMX enhancements, speed not critical, 260MHz or better, minimum 64MB RAM, minimum 4MB dedicated video RAM, 2GB ATA storage 12msec access or better, PCI bus. Expansion options for later addition of modem or ethernet card. Parallel, serial and mouse ports, VGA out, NTSC out is desirable.
- 16 bit SoundBlaster sound card or better. Self powered amplified stereo speakers optimized for 20Hz-20KHz range, minimum 30 watts per channel.
- An external, wall-mounted, large electronic display board for magnified wall projection. This is a rapidly (by the month) evolving field. A typical current contender is the rear-projection "SmartBoard" by Smart Systems. The selected board should be large enough (minimum 4'x3') to enable comfortable simultaneous viewing by a group of 8 adults in addition to the person interacting with the kiosk interface.

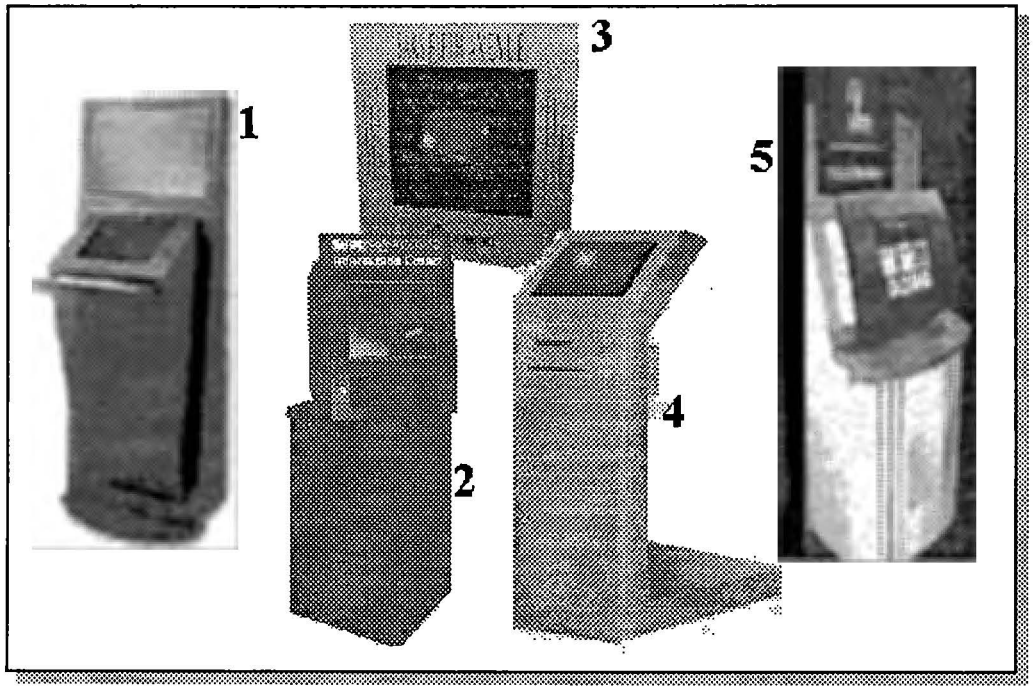

Figure 2. Examples of kiosk styles.
1&3- KIS Kiosk Information Systems, Denver CO; 2- Gibco Kiosks, Brooklyn, NY
4- Winstanley, Inc.,Traverse City, MI; 5- TouchVision Systems, Seal Beach, CA

What might the installed kiosk setup look like?

The final deployed appearance will be determined in collaboration with the hosting institutions. Figure 3-b (below, right) shows one basic arrangement, in use at the Museum of London. The system proposed for EVOSTC will include 2 or 3 articulated "backdrop" panels, similar to those shown in Figure 3-b; however our panels will feature a large text title banner, EVOSTC logo, reference maps, and an attractive photo-montage illustrating the basic theme of the exhibit. Figure 3-a (below, left) shows the opening screen of a kiosk in long use at the Smithsonian. This one happens to be promoting membership via electronic signup and so it takes the metaphor of an electric envelope. Nonetheless, notable design features include an attractive, interesting appearance; clear, large easy to read text; clear and simple opening instructions; and a navigation bar occupying the same location through all screens.

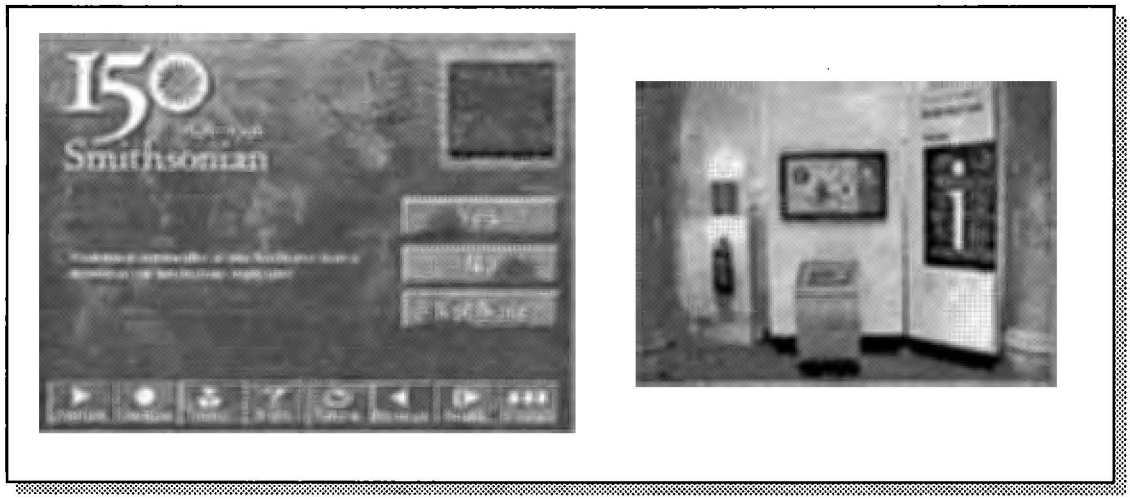

Figure 3. Examples of kiosks in use for public information display.
Left- Touchscreen opening menu for a kiosk at the Smithsonian.
Right- Physical layout of an information kiosk at the Museum of London.

Is there a reference for how to build these things?

The Los Alamos National Laboratory conducted a system-design project to facilitate creation of kiosks for use in the National Information Infrastructure (NII) initiative. A report on this program (the Los Alamos Information Systems Technology, LIST, program) provides a thorough discussion of technical design considerations in kiosk deployment (Morris *et al.*, 1995). The issues documented are still the major design considerations in 1999, and, with the exception of the internet connectivity discussion, are pertinent to the project proposed here.

What about Internet connectivity?

This proposal specifies standalone structures in order to keep the project fiscally feasible at this time. For the present, the kiosks are fully functional and useful as standalone self-contained units. However, the hardware will be specified with expansion in mind; that is, we will attempt to reduce the risk of obsolescence of the investment by planning for upgradability. Thus nothing precludes the units from being connected to the Internet in the future if desired. It may be that telecommunications progress in the next 2-3 years will bring the cost and technical logistics of Internet hook-up down to tolerable levels well within the lifetime of these exhibits. Leaving open the possibility of Internet connection in the future likewise leaves open an expanded scope of services which these units could in the future provide. For example, the public could be given access to continuously running ocean models, real-time cameras deployed at points of interest such as bird colonies, continuously updated monitoring data, real-time tracking of tagged animals, and similar adventures.

III. Software

The PI has experience and expertise with all of the following core software packages, which will be used in development of the multimedia content:

- Adobe PhotoShop 5.02 - image creation and manipulation
- Adobe Premiere 5.1 - professional-level digital video editing
- Adobe AfterEffects 3.1 - professional-level special effects
- Macromedia Director 7.0 - multimedia authoring system
- Macromedia Shockwave - streaming video creation
- Sound Forge - digital audio editing
- Bryce 3D - 3 dimensional landscape creation
- Micrografx Simply3D and Flowcharter - 3D object and charting utilities
- AVS 5.2 - advanced visualization system for 3D data display and animation (Unix)
- GMT - script-based mapping libraries (Unix)
- Corel Graphics Suite 8 - used for CorelDraw - vector based drawing

The total value of these software suites at current prices is estimated at over $10,000. All are currently installed, in use by the PI, and available to the proposed project at no new cost.

IV. Work Flow

The production work flow is illustrated in Figure 4.

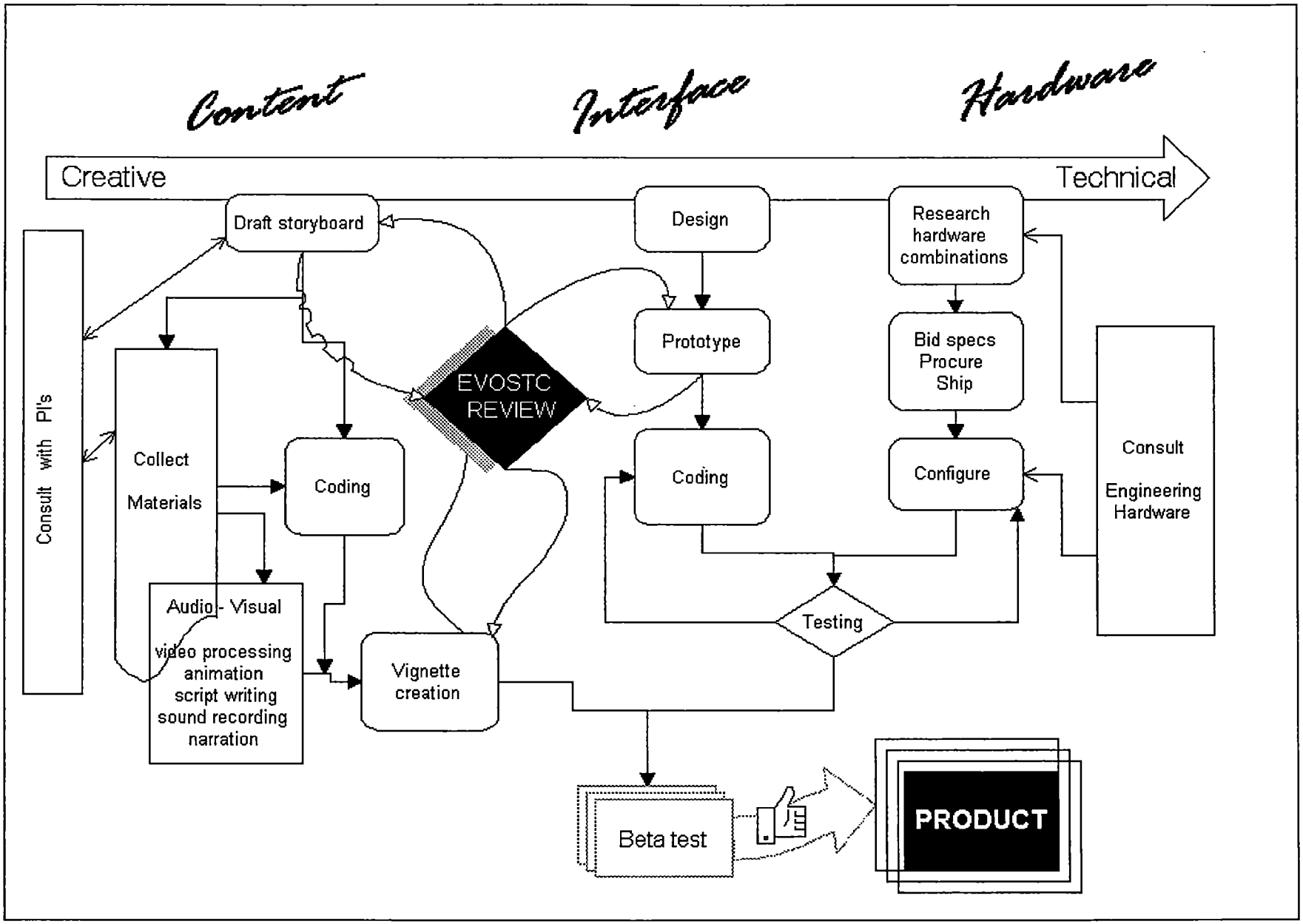

Figure 4: Project Work Flow*.

*Please note that a loop for PI review of final vignettes will exist but is not shown here.

V. Other Questions?

How will this project strive to minimize the potential problems listed earlier?

1- Attracting attention of users, helping users who may be uneasy with technology: A priority will be placed on an appealing and welcoming physical layout and opening screens. When not in use, the video screen will cycle through high profile display segments that attract and draw in passers-by. Background panels will be eye-catching and interesting and will offer large text welcome messages and simple starting instructions. Staff of the hosting institutions will be instructed in use of the system and in ways to welcome and encourage apprehensive users when necessary.

2- Avoiding frustrating /disappointing user experiences: A priority will be placed on ease of use, clarity and friendliness of the interface, according to the guidelines listed and cited above. A priority will be placed on specifying hardware that is technically adequate to fulfill the demands imposed by high bandwidth media. Significant time and effort will be devoted to content specification, organization, design, and artistic creation; in this area as in hardware, quality will not be compromised for expediency. Professional studio services will be used at key production points to ensure the highest quality is maintained.

3- Dealing with system failures: Kiosks cabinets will be outfitted with uninterruptable power supplies that provide at least 60 minutes supply to the equipment after building power failure. Autoboot sequences will be written to streamline return of the system to the correct state after unexpected shutdown. An annual maintenance contract will be specified which provides minimal annual maintenance, on-site service, and component swap-out if required; this proposal will pay for the first year of the maintenance contract. Site selection and general security provided by the host institutions will minimize the risk of vandalism.

What kinds of vignettes will be included?

A mockup example containing sample vignette ideas and prototype interface sketches can be produced on request to assist evaluation of this proposal.

Are there any partnering options to share the cost of this program?

1. The Prince William Sound Science Center has pledged up to $15K to pay hardware costs associated with deployment of an EVOSTC display at one location. This display would be showcased in the new Science Center entry foyer.
2. Once a high quality display has been developed with EVOSTC support, it is likely that other regional institutions will similarly elect to pay hardware costs for installations at their own sites. Also, this investigator has been advised that there is a good likelihood of obtaining additional support for continuation and extension of this work, including expansion to additional sites, from the Oil Spill Recovery Institute (see attached letter).

A. Measurable Project Tasks for FY 00

Measurable project tasks for FY include

- hardware review, bid specification, procurement and configuration
- content selection, story board development, vignette creation
- interface design and programming, content programming
- hardware and software testing
- review and approval by EVOSTC
- system deployment

The time periods for these tasks are shown in Figure 5.

B. Project Milestones and Endpoints

MILESTONE / DELIVERABLE	DATE
Hardware specified Procured, hardware integrated, fully configured	November 30, 1999 May 30, 2000
Software content created	July 31, 2000
Three kiosk displays deployed	September 30, 2000
Toxicity presentation completed	September 30, 2000

C. Completion Date

The anticipated completion date is September 30, 2001.

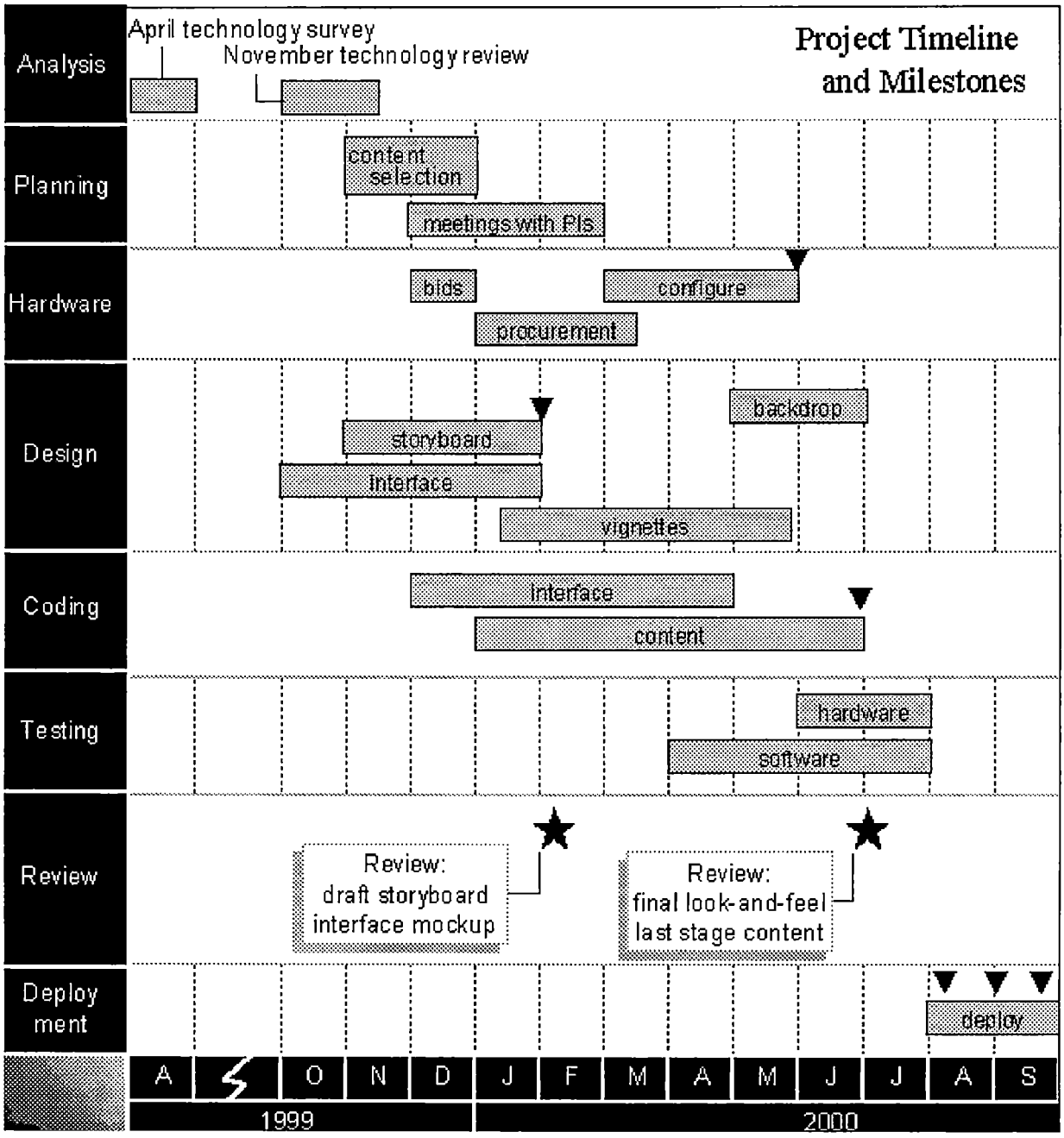

Figure 5. Project timeline, milestones (inverted triangles) and key review dates (stars).

PRINCIPAL INVESTIGATOR

Jennifer R. Allen
Prince William Sound Science Center
P.O. Box 705,
Cordova, AK 99574
tel: 907-424-5800
jrallen@grizzly.pwssc.gen.ak.us

Qualifications: Jennifer Allen has a background in digital image processing, scientific visualization, computer communications, and multimedia production. She has been active for several years in the synthesis and presentation arenas of the SEA program, including development of the SEA presentations at the January 1998 Restoration Workshop and March 1999 10 Year Anniversary Symposium.

EDUCATION

1983	Bachelor of Veterinary Science (First Class Honors) University of Sydney, Australia *[this degree equivalent to the DVM in the Unites States.]*
1985	Residency in Equine Medicine and Surgery, Washington State University, Pullman, WA, USA

EMPLOYMENT

1994-present	Technical Project Manager and Information Systems Specialist Prince William Sound Science Center, Cordova AK
1989-93	Research Assistant and Teaching Assistant Program in Statistics, Washington State University, Pullman WA
1985-89	Research Associate College of Veterinary Medicine, Washington State University
1984-85	Resident in Equine Medicine and Surgery College of Veterinary Medicine, Washington State University

SELECTED PUBLICATIONS

Cooney, R.T. and Allen, J.R. (1999) Sound Ecosystem Assessment (SEA): Ecological controls of pink salmon and herring production in Prince William Sound, Alaska. Presented at Exxon Valdez Oil Spill 10 Year Anniversary Symposium, Anchorage, AK, March 1999.

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Allen, J.R., Patrick, E.V. and Thomas, G.L. (1997) Scientific visualization in model-based study of a marine ecosystem. Presented at 127th Annual Meeting American Fisheries Society, Monterey CA, August, 1997.

Patrick, E.V., Mason, D., Kulkarni, R. and Allen, J.R. (1996) The SEA evolution equation model for pink salmon fry: Results and visualization of the subecosystem of northwest Prince William Sound. Presented at AGU 1996 Spring Meeting, San Diego, February 1996

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National Research Council (1997) More than Screen Deep: Toward Every-Citizen Interfaces to the Nation's Information Infrastructure. National Academy Press, Washington, DC.

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Platten-Killeen, J., Muss, T., Stokes, J., *et al.* (1998) DEA 470 Usability Project: Herbert F. Johnson Museum of Art. Ergonomic evaluation of kiosk and visitor software prototype. *http://ergo.human.cornell.edu/ErgoPROJECTS/museum98*

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Williams, R. (1994) The Non-Designers Design Book. Design and Typographic Principles. Peachpit Press, Berkeley, CA.

Wilson, S. (1993) The aesthetics and practice of designing interactive computer events. SIGGRAPH 93 Visual Proceedings Art Show Catalog. *http://userwww.sfsu.edu/~swilson/papers/interactive2.html*

X-Sender: loon@grizzly.pwssc.gen.ak.us
Date: Mon, 12 Apr 1999 17:42:43 -0800
To: jrallen@grizzly.pwssc.gen.ak.us
From: Gary Thomas <loon@pwssc.gen.ak.us>
Subject: kiosk proposal
Mime-Version: 1.0

Jennifer Allen:

Your proposal for using kiosks to communicate science findings to the public is an excellent idea. This concept has been highly successful at the Pacific Science Center in Seattle. I have talked with Science Center Board members and they are very supportive of this idea. I feel that we can commit $10-15,000 for hardware to support installation of an educational kiosk at the Science Center, if you think that is possible.

I also talked with some OSRI Board members who liked the idea of having educational kiosks at other institutions in the spill affected region such as the ASC, Pratt Museum, FTIC, EVOS Library or Imaginarium, and the Valdez Convention Center. Maybe these institutions would be interested in providing the hardware (like the Center) if you get the EVOS funding to put the systems together. The OSRI education grants are usually in the $15-40,000 range so I would encourage you to apply if you need matching to help carry out the EVOS 2000 grant.

Keep up the good work.

Gary Thomas
President, PWSSC

FY 99 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$0.0
Travel		$0.0
Contractual		$154.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$154.0
General Administration		$10.8
Project Total	$0.0	$164.8
Full-time Equivalents (FTE)		0.6
Other Resources		$15.0

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 2001	Estimated FY 2002			
	$0.0	$0.0			

Dollar amounts are shown in thousands of dollars.

Comments:

$15 K matching funds from PWS Science Center

FY 00

Prepared: 04/12/99

Project Number: 00414-BAA
Project Title: Interactive Information Display for the Public
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 99 EXXON VALDEZ TRU **COUNCIL PROJECT BUDGET**

October 1, 199 ptember 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$45.5
Travel		$5.4
Contractual		$25.1
Commodities		$15.5
Equipment		$36.8
Subtotal	$0.0	$128.3
Indirect		$25.7
Project Total	$0.0	$154.0
Full-time Equivalents (FTE)		0.58
Other Resources		$15.0

LONG RANGE FUNDING REQUIREMENTS	
Estimated FY 2001	Estimated FY 2002
$0.0	$0.0

Dollar amounts are shown in thousands of dollars.

Comments:

$15 K matching funds from PWS Science Center

FY 00

Prepared: 04/12/99

Project Number:
Project Title: Interactive Information Display for the Public
Name: Jennifer R. Allen
Agency: NOAA

FORM 4A
Non-Trustee
SUMMARY

FY 99 EXXON VALDEZ TRU[S] COUNCIL PROJECT BUDGET

October 1, 199[9] – [S]eptember 30, 2000

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 2000
Jennifer R. Allen	Info Systems / Communications Specialis[t]		7.0	6.5		45.5
						0.0
	(displays: 6 months					0.0
	toxicity presentation: 1 month)					0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		7.0	6.5	0.0	
					Personnel Total	$45.5

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
					0.0
Cordova-Anchorage	0.20	3	10	0.10	1.6
Cordova-Seward	0.45	2	6	0.10	1.5
Cordova-Fairbanks	0.35	1	4	0.10	0.8
Cordova-Juneau	0.30	1	5	0.10	0.8
EVOSTC Workshop January 2001	0.20	1	5	0.10	0.7
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5.4

FY 99

Prepared: 04/12/99

Project Number:
Project Title: Interactive Information Display for the Public
Name: Jennifer R. Allen
Agency: NOAA

FORM 4B
Personnel
& Travel
DETAIL

FY 99 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET
October 1, 1998 - September 30, 2000

Contractual Costs:	Proposed FY 2000
Description	
audio/video studio time and services	10.0
maintenance contract for kiosk hardware, 2 sites	2.0
network connectivity -- 6 person months @ $100/mo	0.6
telephone	1.5
photocopying	0.5
postage/shipping	5.0
software - MPEG encoder/editor	5.0
software - Debabelizer Pro	0.5
Contractual Total	$25.1

Commodities Costs:	Proposed FY 2000
Description	
office supplies	0.5
computer supplies	10.0
photographic and video supplies	5.0
Commodities Total	$15.5

FY 99

Prepared: 04/12/99

Project Number:
Project Title: Interactive Information Display for the Public
Name: Jennifer R. Allen
Agency: NOAA

FORM 4B
Contractual & Commodities DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
			0.0
kiosk enclosures and surrounding frames	2	4.0	8.0
kiosk touch screens	2	2.0	4.0
internal computer subsystems	2	5.0	10.0
large view electronic boards for wall-mounted group display	2	5.0	10.0
IBM Thinkpad 770 model 954982U	1	4.8	4.8
			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**	$36.8

Existing Equipment Usage: Description	Number of Units
Sun Sparc20-ZX/192MB workstation	1
HP Scanjet II color scanner	1
Codonics dye sublimation color printer	1
S&F Rocket 8020 CD-Recorder	1
Iomega 2GB Jazz drive	1

FY 99

Prepared: 04/12/99

Project Number:
Project Title: Interactive Information Display for the Public
Name: Jennifer R. Allen
Agency: NOAA

FORM 4B
Equipment
DETAIL

O'Brien Creek Restoration

Project number:	00416
Restoration Category:	General Restoration
Proposer:	The Chenega Corporation
Lead Trustee Agency:	USFS
Cooperating Agencies:	None
Duration:	1st year, 2-3 year project
Cost FY 1999:	$27.2
Cost FY 2000:	TBD
Cost FY 2001:	TBD
Geographic Area:	Prince William Sound
Injured Resource:	Subsistence

ABSTRACT

Subsistence use of resources in the EVOS area declined following the spill in 1989. Unlike many of the other oil spill communities, subsistence harvest levels in Chenega Bay have not returned to pre-spill levels. This project seeks to help the recovery of subsistence users in Chenega Bay by restoring the water flow to O'Brien Creek. The 1964 earthquake resulted in out-wash deposits that caused the stream to become subterranean at low flow levels. This project would examine the feasibility of restoring the channel so that salmon have access to the stream and will also identify opportunities to improve rearing habitat.

INTRODUCTION

Subsistence activities for residents of Prince William Sound have been severely disrupted by the *Exxon Valdez* Oil Spill, and none more so than the subsistence activities for residents of Chenega Bay. While subsistence harvest levels in many of the communities have returned to pre-spill levels, harvest levels at Chenega Bay are still reduced (Seitz and Fall, 1995). Providing subsistence opportunities that are easily accessible to the residents of Chenega Bay would help subsistence users recover from the effects of the oil spill.

O'Brien Creek (ADF&G stream number 665) is located in Crab Bay between the community of Chenega Bay and the town's airstrip. At low water flows the stream flows under a broad gravel flat at is mouth, sometimes preventing hundreds of salmon spawning. The close proximity of the stream to the community would provide easy access to subsistence activities for all Chenega Bay residents. Relatively little information is available on historical and current salmon use in this creek because it has not been monitored for escapement by Alaska Department of Fish and Game. However, initial discussions to gather traditional ecological knowledge, local residents suggest that chum (*Oncorhynchus keta*) and pink salmon (*Oncorhynchus gorbuscha*) are abundant in the intertidal areas (D.Kompkoff, personal communication 1996). The Anadromous Stream Catalog identifies the stream as having pink and chum salmon populations; however, the 1964 earthquake resulted in out-wash deposits that caused the stream to become subterranean at low flow levels. O'Brien Creek was identified and recommended as a potential enhancement site in the Prince William Sound-Copper River Comprehensive Salmon Plan, phase II 5-year plan (1986-1991).

This proposal seeks to verify the feasibility of restoring O'Brien Creek as an anadromous fish stream and to complete the design and NEPA work necessary to provide access and rearing habitat for salmon.

NEED FOR THE PROJECT

A. Statement of Problem

Subsistence use of resources in the EVOS area declined following the spill. Although restoration studies have shown that overall harvest levels have since returned to prespill levels in most oil spill communities, Chenega Bay and Tatitlek are exceptions (Seitz and Fall, 1995; Seitz and Miraglia, 1995). These communities showed reduced harvest levels in 1993/94 and a corresponding increased reliance on salmon harvests (Seitz and Fall, 1995; Seitz and Miraglia, 1995; EVOS 1998). In addition, the *Exxon Valdez* Restoration Office's Invitation to submit proposals for FY97 stated that subsistence users are traveling greater distances and invest more time in subsistence harvesting than they did prior to the spill. O'Brien Creek flows near Chenega Bay and provides for the implementation of a restoration project that would be accessible to all

Chenega Bay residents. The 1998 EVOS evaluation of subsistence recovery states that local residents continue to be concerned about passing traditional knowledge to their children. Easy access to a subsistence source may assist Chenga Bay residents convey subsistence values and traditions to village youth.

B. Rationale/Link to Restoration

Restoration of O'Brien Creek will directly benefit the subsistence users of Chenega Bay by increasing the number of salmon that could be harvested. Excavation of the out-wash berm will allow for chum and pink salmon to access the creek for spawning and rearing. The community is also interested in seeing coho salmon established in Crab Bay and this stream may provide an opportunity to create a permanent run in Crab Bay in coordination with ADF&G's current stocking program. Based on information from the oil spill channel typing data, O'Brien Creek has approximately 5700 meters of channel types that are considered suitable salmon habitat. Detailed information on the availability of spawning and rearing habitats will be collected during the first phase of the project.

C. Location

This project is located in ADF&G stream number 665, in Crab Bay on Evans Island, Prince William Sound.

COMMUNITY INVOLVEMENT

This project was initiated at the request of The Chenega Corporation. Community involvement is planned as an integral part of all stages of this project. The 2000 feasibility assessment will involve the residents of Chenega Bay to gain local knowledge of historical and existing escapement levels on the stream. Children from Chenega Bay and other communities may be involved in conducting the stream survey of the creek and we would look for opportunities to include other residents during the preliminary design and feasibility assessment of the creek. The 2000 phase of the project will also determine if local equipment and operators can be used to restore the channel.

After implementation, residents of Chenega Bay will be responsible for maintaining and monitoring the stream with assistance from the Forest Service. Coordination with a program such as the Youth Area Watch Program (96210) could provide additional local involvement in the implementation of this project. Potential opportunities include conducting escapement counts and monitoring the juvenile salmon populations.

PROJECT DESIGN

A. Objectives

1. Investigate the feasibility of excavating the lower portion O'Brien Creek to increase salmon availability for subsistence harvest.

2. Determine the feasibility of creating rearing habitat for coho salmon in O'Brien Creek.

3. Involve residents of Chenega Bay in the planning, survey, design and implementation of the project.

B. Methods

Feasibility Assessment (FY20): During 2000, residents of Chenega Bay will be interviewed for information on fish runs in O'Brien Creek. This information will be helpful in understanding the historical use of the system. The interviews will be followed by an inventory of spawning and rearing habitat using a modified Hankin and Reeves (1988) procedure which provides quantitative measurements of habitat types. Stream reaches are divided into habitat types based on flow patterns and channel bed shape (pools, riffles, glides etc). Physical parameters of the habitat types would be measured or estimated and descriptions of substrates and available cover will be recorded. This information will also be used to update existing channel typing information for O'Brien Creek. Live traps and snorkeling will be used to determine the presence, and extent, of any fish species already using the creek.

Based on interviews and field observation, the ephemeral pattern of O'Brien creek will be determined. A preliminary design to excavate the portion of the stream that currently becomes subterranean will be completed in FY00. Designs will also be provided for creating upstream rearing habitat that may be necessary to provide habitat for coho salmon. Final engineering designs necessary for obtaining the appropriate Title 16 and 404 permits would be completed the following winter (FY01).

Implementation: Although the details of implementation cannot be determined until the feasibility study is completed, it is anticipated that the majority of the excavation and installation of structures would be completed in the year 2001.

Monitoring and Maintenance: Project monitoring and maintenance of the channel and any rearing habitat structures will occur in the years following completion of the project by residents of Chenega Bay and by the USFS. Increases in salmon production and subsistence use will be documented. The creek will be walked to document escapement levels. Forest Service biologists will work with Chenega Bay residents to develop a schedule and methods for the residents to use when conducting escapement surveys.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The Alaska Department of Fish and Game will provide assistance during the development of the environmental analysis and escapement monitoring. Coordination with the PWS Regional Planning Team will occur so that this project can be incorporated into their management planning for Prince William Sound.

SCHEDULE

A. Measurable Project Tasks for FY00

October-November:	Obtain historical data and preliminary information residents of Chenega Bay.
October- March:	Work with the Regional Planning Team to gain acceptance of the project.
January:	Attend Symposium
March-May:	Begin Scoping for NEPA
May-August:	Conduct field surveys
September:	Complete NEPA, coordinate with ADF&G to finalize preliminary designs, submit updated proposal for FY01

Project Milestones and Endpoints

Survey, design, and environmental compliance under NEPA will be completed in 2000 and all construction work on the project would be completed in 2001 or 2002. The project will be monitored and maintained by people from Chenega Bay with assistance from the USFS.

March:	NEPA process initiated
August:	Preliminary designs and field surveys completed
September:	NEPA completed
FY01	
October-March:	Designs finalized; Obtain Title 16 and 404 permits, coordinate implementation
May-July:	Project implementation

August: Initial project monitoring

FY02:
October-March: Establish monitoring program

May-August: Monitor the project and complete installations if necessary.

Completion Date

The project completion date will be determined after the completion of the FY00 work. It is anticipated that the project implementation would be completed in FY01; however, depending on the outcome of the feasibility study, additional work could occur in FY02.

PUBLICATIONS AND REPORTS

Annual reports will be prepared during each year of the project and preliminary reports on the feasibility assessment will be provided to the Trustee Council in late October 2000. NEPA compliance will be completed in September 2000. The final report for the project will be submitted in October 2002.

NORMAL AGENCY MANAGEMENT

This project is on Chenega Bay land, which is not managed by the Forest Service. The Forest Service has experience in the design and installation of fish habitat improvement structures in Alaska, but would not generally work on land not managed by the agency.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project proposal has been submitted at the request of The Chenega Corporation and provides an opportunity to enhance the coordination of the EVOS restoration program with the local residents (Community Involvement 98052A). The proximity of O'Brien Creek to Chenega Bay may also make it an ideal candidate for coordination with the Youth Area Watch Program (98210). Coordination with this program may provide an opportunity to establish long-term monitoring by the residents of Chenega Bay.

PROPOSED PRINCIPAL INVESTIGATOR

The principal investigator of this project will be Robert Spangler, the Fisheries Biologist at the Glacier Ranger District of the Chugach National Forest.

Robert Spangler (Fishery Biologist)
Glacier Ranger District
Chugach National Forest
P.O. Box 129
Girdwood, AK. 99587
(907) 783-3242

PERSONNEL

Robert Spangler is a fisheries biologist with the U. S. Forest Service, Glacier Ranger District, Chugach National Forest. He obtained his B. S. degree in Fisheries from Oregon State University and a M. S. Degree in Fisheries Science from the University of Idaho. He has worked primarily with cold water fishes of the western U. S. and has a total of ten years of fisheries experience in Oregon, Idaho, Montana, and more recently, Alaska.

Daniel Gillikin (Fisheries Biological Technician; Glacier Ranger District) will provide technical support and field coordination of the seasonal employees assisting in data collection for the project. Randy Shrank will provide surveying expertise; Vanessa Aloa-Macleod or another Forest Service fisheries engineer will oversee the engineering design; field crews will be seasonal employees and community residents.

LITERATURE CITED

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of the sociocultural consequences of outer Continental Shelf development in Alaska; II. Prince William Sound. MMS 95-011; Technical Report No. 160.

Seitz, J. and R.Miraglia. 1995. Chenega Bay. In: Fall, J.A and C.J. Utermohle, (eds). *An investigation of the sociocultural consequences of outer Continental Shelf development in Alaska; II. Prince William Sound.* MMS 95-011; Technical Report No. 160.

2000 EXXON VALDEZ TRU E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$17.3
Travel		$0.0
Contractual		$2.4
Commodities		$4.7
Equipment		$0.0
Subtotal	$0.0	$24.4
General Administration		$2.8
Project Total	$0.0	$27.2
Full-time Equivalents (FTE)		2.5
Other Resources		$10.8

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		TBD	TBD		

Dollar amounts are shown in thousands of dollars.

Comments:

FY00

Project Number: 00416
Project Title: O'Brian Creek Restoration
Agency: U. S. Forest Service

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: 4/6/99, KEH

2000 EXXON VALDEZ TRI E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
R. Spangler	Fish biologist	GS-9	4.5	1.5		6.8
D. Gillikin	Fish tech	GS-9	4.5	0.5		2.3
vacant	Bio tech	GS-7	2.8	1.0		2.8
Vacant	Bio tech	GS-5	2.3	1.0		2.3
C. Hubbard	Plant ecologist	GS-9	4.5	0.2		0.9
M. Gilliam	Archaeologist	GS-9	4.5	0.2		0.9
D. Blanchet	Hydrologist	GS-12	6.6	0.2		1.3
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		29.7	4.6	0.0	
					Personnel Total	$17.3

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY00

Prepared:

Project Number: 00416
Project Title: O'Brian Creek Restoration
Agency: U. S. Forest Service

FORM 3B
Personnel
& Travel
DETAIL

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

Contractual Costs:	Proposed
Description	FY 2000
Charter flight (6hrs @ $400.00/ hr)	2.4
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$2.4

Commodities Costs:	Proposed
Description	FY 2000
boat fuel	2.0
train ticket (truck)	0.1
train ticket (personal)	0.3
train ticket (boat)	0.4
food ($18.00/ day for 75 days)	1.4
misc supplies	0.5
Commodities Total	$4.7

FY00

Prepared:

Project Number: 00416
Project Title: O'Brian Creek Restoration
Agency: U. S. Forest Service

FORM 3B
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 2000
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
stream survey equipment	1	5.5
boat ($350.00/ day for 15 days)	15	5.3
		10.8

FY00

Project Number: 00416
Project Title: O'Brian Creek Restoration
Agency: U. S. Forest Service

FORM 3B
Equipment
DETAIL

Prepared:

THE 1899 HARRIMAN ALASKA EXPEDITION RETRACED: A CENTURY OF CHANGE

Project Number: 00418

Restoration Category:

Proposer: Clark Science Center, Smith College

Lead Trustee Agency:
Cooperating Agencies:

Alaska Sea Life Center: No

Duration: 2nd year, 3-year project

Cost FY 00: $126,500

Cost FY 01: $126,500

Cost FY 02: $0

Geographic Area: Prince William Sound, Kodiak, Kenai Peninsula

Injured Resource/Service:

ABSTRACT

The project will bring scientists, naturalists, and artists to the Alaskan coast to observe anew the sites visited by the Harriman Alaska Expedition of 1899. Florentine Films/Hott Productions is producing two one-hour films for broadcast, and an educational and outreach program, that will bring together the dynamic elements of both the 1899 and modern expeditions. The viewer will be introduced to the coast affected by the spill, to the conflict between resource management and preservation, and to the restoration efforts of EVOS.

INTRODUCTION

SUMMARY OF REQUEST

This is a major film and education project with a combined budget of approximately 1.5 million dollars. We are asking EVOS for only a small portion of the funding of the project. The request is justified because the project will emphasize and explain the restoration of injured resources brought about by the efforts of the Exxon Valdez Oil Spill Trustees Council.

The two-hour film will be broadcast nationally on PBS and will reach between ten and twenty million viewers. The educational materials -- study guide, web site, CD-Rom and companion book -- will be used by many thousands of students in both Alaska and the rest of the nation. International distribution of the film will increase the number of viewers by several million. The film will also be available to schools, government agencies, museums, and individuals.

PROLOGUE AND THEMES

One day in March, 1899, Edward H. Harriman strode briskly into the office of C. Hart Merriam, chief of the U.S. Biological Survey. Without appointment or introduction, Harriman launched into a grandiose plan for an expedition by boat along the coast of Alaska. Merriam thought the man a lunatic, and briskly tossed him out. But Harriman would not stay out. He returned the next day, and convinced Merriam that he was not crazy, he was rich; in fact, he was a railroad tycoon, and one of the richest men in the world. This time Merriam listened as the millionaire laid out his plans: refit the veteran steamer, the *George W. Elder*, and then, with a score of the nation's leading scientists, explore the coast of Alaska from the panhandle to the Bering Strait. The expedition would be conducted entirely at Harriman's expense. Merriman would be chief scientist on board. He could choose the scientists, direct their explorations and research, and oversee publication of the results.

C. Hart Merriam had been with the Biological Survey for years, long enough to know that regional surveys in Alaska were hardly original: scientific expeditions of America's vast territories had been going on for decades. But he also knew that such trips were impractical, and, at this date, far too costly to be undertaken at government expense. Here was a man offering him the chance to do a comprehensive exploration of a 5500-mile stretch of one of the most beautiful and mysterious regions on

the globe. Merriam's exact response is lost to history, but we can imagine his answer was something along the lines of, "Where do I sign?" Within hours, Merriam began planning the Harriman Alaska Expedition of 1899.

That summer the expedition returned with over 100 specimen crates and over 5000 photographs and illustrations. The scientists took 12 years to compile 13 volumes of data. Ground-breaking discoveries were few -- a new fjord and glacier, for example -- but the value of the survey of an environment-in-flux is unparalleled. The expedition took place at a time when Alaska's patina of pure wilderness was wearing thin. Mines proliferated, salmon canneries operated round the clock, and fur seal rookeries exported thousands of skins every year. The Native population competed with Chinese laborers for low-wage jobs in fish factories; in some areas, native villages had been reduced to a tourist attraction. The Harriman scientists were able to chchronicle an Alaska on the cusp of inevitable and devastating change.

Florentine Films/Hott Productions, in cooperation with Smith College, proposes to produce a two-hour documentary film and education project, THE HARRIMAN EXPEDITION RETRACED, a look at the journey in 1899 and a profile of a contemporary expedition a century later. THE HARRIMAN ALASKAN EXPEDITION RETRACED began in the fall of 1998 with a scouting trip. Preliminary filming will begin in the summer of 1999, during which time we will film preliminary interviews, archives, and locations both in and outside Alaska. The final filming will take place aboard an expedition ship in early summer, 2000. As in 1899, the ship's passenger list will include scientists from a range of disciplines. Editing and finishing work will be completed in the fall of 2000.

The film will explore three key themes that emerged during the voyage but still have great relevance today. The first theme is that of scientific bench mark: the original expedition resulted in a profusion of general base-line data on coastal Alaska, including studies of Orca, Chenega Bay, and Kodiak Islands,areas affected by the oil spill. The expedition also proved to be veritable case book of the specimen collection mania that marked late 19th century science: Wesley R. Coe collected nine-foot worms; William Dall collected mammoth (species and size) dung samples; on one day, Albert K. Fisher bagged forty-five mammals and twenty-five birds for study. This was, he noted, "not nearly enough." Adequate or no, the Expedition findings serves as a yardstick by which we can measure changes in dozens of the species to be found in America's largest, wildest state.

The second theme is the changing nature of exploration and an examination of the ways in which world conditions shape scientific inquiry. The Harriman scientists based their experiments, techniques and observation methods on their view that Alaska was a largely untouched wilderness. Today scientists in all disciplines must, of necessity, assess the human impact on the environment. Since 1989, the oil spill has been the salient event, literal and symbolic, that shapes inquiry into the nature and condition of Alaska's coast. In THE HARRIMAN EXPEDITION RETRACED contemporary scientists will revisit century-old observations and juxtapose these with contemporary research, offering the viewer insight into the transformation science has undergone since the 19th century.

The very make up of the scientists on board the original trip and the new expedition speak to transformation. Harriman was careful to include classic 19th-century generalists, John Muir, John Burroughs and George Bird Grinnell -- men so enchanted with the natural world they were content to observe, to name and to number every new-found bit of it. But Merriam also recruited specialists, forester Bernhard Fernow, geologists G. K. Gilbert and Benjamin Anderson, seismologist Charles Palache. Even then, the specialist was in the ascendent in the world of science. But for two months, at the close of the last century, these two kinds of scientists stood comfortably together on the decks of the *Elder*, and watched as the coast of Alaska unfolded its beauty to them in a regal procession of wood, water, rock and ice. The retraced expedition will include scientists from the full range of disciplines addressing the coast today: Plant-Forest Ecologist Marine Mammologist, Fisheries Biologist/Marine Scientist, Ornithologist Biologist, Geologist, Paleontologist, Alaskan Native Cultural Anthropologist, Historian, Philosopher of Science and Society.

The third theme is that of the two Alaskas: the first the physical region, resource-rich, exploitable, knowable. The second Alaska is that of the imagination, a vast, pristine wilderness. Before the spill, the two Alaskas seemed to many of us to co-exist. Even the Alyeska pipeline seemed somehow benign. The spill, by comparison, seemed a veritable collision between the real and the imagined Alaska. This conflict will be examined in THE HARRIMAN EXPEDITION RETRACED; the film's narrative and commentary will consider the perspectives on that boat one hundred years ago, when men with a deep reverence for untrammeled wilderness shared ideas -- and cabins -- with men who believed, passionately, that nature was there to be first inventoried, then used. This history will be juxtaposed with the perspectives of

today's scientists, who are studying the effects of the spill on the coastline.

The Harriman Alaska Expedition of 1899 would prove the last of its kind. It took place at a time when America was, as a country, leaving its wilder past behind, and taking its first steps towards modernity. The trip reflects something of the ambivalence the nation felt in taking these steps, for as much as Americans wished to move forward as an industrializing nation, they also wished to hold onto the raw, wildness that had, according to some, shaped their national character. G. K. Gilbert characterized the results of HAE as "reconnaissance," an over-arching confirmation of things known rather than an exposition of things hitherto secret. But the reports are, by any standard, a marvelous work: thirteen large volumes, benchmarks that give us a picture of the Alaskan coast in 1899, and the science that goes into the making of the picture. Volumes I and II, narratives published for the general public in 1901 were popular successes, celebratory, erudite and gossipy by turns. One hundred years later these two volumes have become a study in anthropology as well as natural history: Alaska, the totemic symbol of North American wilderness; the scientists, an eager tribe singing its praises even as they storm its shores.

Today, America is poised, as were the Harriman Expedition participants, for the passing of a century and closure to a distinctive era in American history. Significantly, the expedition will mark its 100th anniversary in the Summer of 1999. But we are also marking another anniversary: the end of the first post-spill decade. As we pass these milestones, it seems natural to ask questions about Alaska's history and assess its role in shaping and influencing the world's ecological and social communities.

In ways the Harriman Alaska Expedition may not have intended, they have provided a bench mark for Americans to assess their relationship with the natural world, the resources that support our existence, and our relationships with each other as human cultures sharing a single planet. The scientists and artists who participated in the expedition have left a legacy of data and images for us to examine. The coast of Alaska, as seen through the eyes of the 1899 expedition, gives us a milestone to assess how far we have come, take stock, and consider where we might be going.

NEED FOR THE PROJECT

A. Statement of the Problem

Public understanding of an ecological disaster on the scale of the Exxon Valdex was shaped by the media during the immediate aftermath. Millions of Americans saw the disturbing images of oil-soaked birds, the beaches stained to black. But in the weeks following the spill other events dominated the news. The Exxon Valdez spill was understood as one disaster among many in the modern world.

Scientists understand the spill in very different terms. For the past ten years the research into the effects of the spill has been broad and particular. Scientists studied its impact on sea otters, harbor seals, killer whales, bald eagles, water fowl and myriad species of birds. "The immediate impact was severe, devastating," says ornithologis John Piatt. "Ten years later we're still finding damage. Who knows how long into the next century the harm will last."

The film and educational materials will report on the changes in several key areas of concern: the fishing industry, land acquisition and habitat protection, conflicts within the Native communities over development, sea mammal and bird health and population, subsistence issues, and the impact on passive use -- the image of Alaska, the effect on the tourism industry and the long-term financial and emotional stress of the Alaskan residents affected by the spill.

We will address these complex issues by revisitng the sites the original cruise examined and assessing the changes in the animal, plant, and human communities. These sites include Orca/Cordova, Valdez, College and Harriman Fjords, Tatitlek, Chenega Bay, and Kodiak Island. The film will emphasize and explain the restoration of injured resources brought about by the efforts of the Exxon Valdez Oil Spill Trustees Council.

The original expedition will give the film its chronological structure. The production will start with Harriman's search for the best scientists, follow the cruise from Seattle to the Bering Straits and back again, and end with the thoughts and conclusions of the original expedition members. In between we will use many of the photographs and hundreds of colored illustrations and paintings produced by Edward Curtis and other expedition members, and live, 16mm color cinematography to compare the old Alaska with the new. Throughout the film, modern day scientists and historians, both on the new expedition and off, will provide insight and analysis.

B. Rationale/Link to Restoration

THE HARRIMAN EXPEDITION RETRACED film and education program will serve a critical function in the public education process about the effects of the Exxon Valdex spill. The viewer will be introduced to the coast affected by the spill, to the conflict between resource management and preservation, and to the restoration of injured resources made possible by the Exxon Valdez Oil Spill Trustees Council.

Introduction to the Alaskan Coast: On June 23, 1899 the George W. Elder steamed out of Yakutat Bay and headed north towards Prince William Sound. Over the next two weeks the ship paralleled the course of the 1989 Oil Spill: Orca, Golofnin Bay, then Barry Glacier, supposedly the end of navigable waters in the Sound. Here, defying Captain Doran's warnings that to proceed further would court disaster, Harriman pressed on and soon discovered a new fjord, and within it a large glacier. In the tradition of the great explorers, he named both after himself. Harriman's insistence that the *Elder* move into uncharted water is a wonderful example of the hubris that has marked, for well and ill, many of the human events that shape Alaska's coast.

Exploitation and preservation: When the scientists and writers returned to their homes they each wrote a chapter for the voluminous report that Harriman planned to publish. Their writing focusses on things that can be seen as elements of the wilderness, but also as resources to be tapped: the salmon, the Alaskan forests, the minerals, particularly copper and gold. Harriman looked to the very land itself, seeing it as a new northwest passage through which he could send his locomotives across the Bering Strait, thereby circling the globe with rail. But no one made mention of the resource that would loom so large in 20th century Alaska: oil.

Today it is impossible to discuss changes in the Alaskan environment without mentioning Prudhoe Bay, the Alyeska Pipeline, Valdez, and the Exxon Valdez Oil Spill. The State of Alaska derives more than eighty per cent of its income from oil revenues, which, through state services and the Permanent Fund, affect every resident of the state. The retracing of the Harriman Alaska Expedition will confront directly the issues the Exxon Valdez Oil Spill Trustees Council has addressed for the past ten years. In this process the viewer will learn about how the Exxon Valdez Oil Spill Trustees Council has brought about the restoration of injured resources and provided habitat protection for a variety of species.

C. LOCATION

The Harriman Alaska Expedition Retraced will follow the original itinerary of the 1899 expedition. The voyage entered Alaskan waters just north of Prince Rupert and hugged the coast along the Gulf of Alaska, spent nearly two weeks in Prince William Sound, the Kenai Peninsula, and Kodiak, and then toured the Aleutians before heading for Bogoslof Island, St. Mathew Island, St. Lawrence Island, Provideniya, and Nome.

The film will be designed for broadcast on PBS and will be accompanied by a study guide for secondary and college students. A web site will include interviews with the project participants, the study guide, and a full transcript of the film. Hyperlinks will connect the web site to the extensive internet material available about the Harriman Expedition. The film's broadcast will be a major media event that will spur interest in the nature of scientific expeditions, past and present, and acquaint the viewer with changes in the environment of one fragile location over the course of a century. The film will be broadcast nationally on PBS and will be repeated several times in Alaska. The presenting station for the PBS broadcast will be KTOO-Juneau.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

STUDY GUIDE

Because the film fits directly into the curriculum content in many school programs, we will work with our consultants to develop a study guide for teachers, Grades 10 and up. The study guide for the project will present a concise and useful bibliography, based on the rich historical record of the Harriman Expedition. The Teacher's Guide will provide classroom teachers with a clear and accessible resource for planning lessons before, during, and after viewing A CENTURY OF CHANGE. The Guide will cover objectives, themes, and teacher-directed activities that follow national curriculum standards.

The study guide will cover the following:

- The impact of the Oil Spill on the locations visited by the old and new Harriman Expeditions
- The nature of scientific expeditions in the 19th century
- The biographies of the key figures involved in the Harriman Expedition

- Changes in scientific method and inquiry since the 19th century
- Science lessons drawn from the original and recent expeditions
- Environmental and social challenges facing the Alaskan coast
- The temper of the times in Alaska and the U.S. in 1899

The guide will include a background essay, curriculum chart (to match curriculum standards with themes in the film,) and evaluation sheet. Other elements are charts, overheads, handouts, visuals, archival photos and time lines. Vocabulary, suggested readings (fiction and non-fiction), and script excerpts will also appear. The length of the guide will be twelve to fourteen pages.

WEB SITE ON THE WORLD WIDE WEB

The producers will create a Web site on the World Wide Web which will include the Study Guide, a complete script of A CENTURY OF CHANGE, photographs and clips from the film, interviews with project consultants and the filmmakers, addresses, phone numbers, and e-mail addresses of scholars and writers involved with the subject matter, bibliography of books on Alaska, and hyperlinks to related web pages on the World Wide Web.

INTERACTIVE CD-ROM

We are applying to the Alaska Science and Technology Foundation for outreach and education funds. If the grant is successful the producers will create two CD-Roms for distribution to Alaska school teachers. The first will be published in mid-winter 2000, before the Expedition. It will include all of the material on the original expedition and information developed for the project up to that time. The purpose of publishing the CD-Rom at this point is to allow Alaskan school children to pose questions, via email and other means, to the projects scholars, scientists, producers, and organizers. These questions will help the participants prepare their research for the expedition, and the answers will be incorporated into the second CD-Rom.

The second CD-Rom will contain the complete study guide, all the material from the Web Site, relevant web sites from Alaskan and federal government agencies, and web sites of the individual scientists working in the field. Students will, once again, have the opportunity to correspond with the project participants. Their reflections on the process, and the record of the student-scientist dialogue, will serve as part of the project evaluation.

In 1999, the year before the recreation, we will film at villages and research sites where the original expedition landed and explored. Then again, in 2000, will film at these sites and also visit them with the full expedition. The itinerary includes many bush villages, from Metlakatla to Kodiak to the Pribiloffs, whose residents rarely have the opportunity for video communication with other locations in the state. In addition to filming in these locations, we are planning satellite uplinks during the expedition that will allow villagers in outlying areas to pose questions in real time to the project participants. The dialogue will be recorded on tape and selected portions will be included on the CD-Rom.

STUDENT/TEACHER PARTICIPATION

Funding from the ASTF will allow us to place two high school teachers on the expedition ship for the entire voyage. They will work with a webmaster on board to provide daily reports and digital photographs to their communities and students. These reports, edited and arranged for the appropriate the curricula, will become part of the second CD-Rom.

PROJECT DESIGN

A. Objectives

THE FILM

Florentine Films/Hott Productions is producing a two-hour documentary film for broadcast and educational distribution that will bring together the dynamic elements of both the 1899 and modern expeditions. The film will weave together four elements: the story of the original cruise, the biographies of its most compelling characters, the comparison of Alaska today with the Alaska of 1899, and commentary by scientists on the modern cruises.

THE BOOK

At least eight renowned scientists and artists, whose expertise parallels those on the Harriman Expedition, will take part in the 2000 expedition. Tom Litwin, director of the Smith College Clark Science Center, will edit a book of essays, photographs, and illustrations contributed by the members of the new expedition.

The book will be a companion piece to the film and will stand on its own as a chronicle of both the 1899 and 2000 expeditions.

EDUCATION AND OUTREACH

The film will be designed for national broadcast and will be accompanied by a study guide for secondary and college students. A web site will include interviews with the project participants, the study guide, and a full transcript of the film. Hyperlinks will connect the web site to the extensive Internet material available about the Harriman Expedition. The film's broadcast will be a major media event that will spur interest in the nature of scientific expeditions, past and present, and acquaint the viewer with changes in the environment of one fragile location over the course of a century.

PUBLICITY

The producers will work with a public-relations firm that has experience promoting media productions. The responsibilities of the project coordinators and public relations firm are to: place reviews and feature stories in magazines and weekly and daily newspapers; obtain interviews and talk show appearances for the producers on radio and television; schedule press screenings of the films; produce brochures indicating the availability of the films for educational and public use; develop and design press kits with press release, brochure, photographs, reviews, biographies, and showing schedule. The Alaska Division of Tourism has expressed a strong interest in working with the project directors to promote the film and education materials statewide and nationally.

SPONSORING ORGANIZATION

The Clark Science Center, at Smith College, is a multi-million dollar, five building complex housing eight academic departments and eighty faculty. The center routinely handles the distribution, administration, and auditing of grants.

RESULTS

The project, The 1899 Harriman Alaska Expedition Retraced, functions on a number of distinct, but closely related levels. While any one of the project's components could be independently pursued, the success and value of the overall project will result from the careful integration of the components. These components include: (a) A voyage that follows the route of the 1899 Harriman Expedition; (b) An academic theme and structure that recreates an authentic and historically accurate retracing of the 1899 expedition, and which is accessible to the ship's passengers for educational enrichment and enjoyment; (c) The production of a PBS quality documentary, and companion education and outreach materials, that will provide the public with an opportunity to appreciate a significant period of American history, and provide an understanding of the role humans play in shaping the global environment; (d) Included will be a 12-14 page study guide that facilitates the integration of project themes into school curricula involving American history and environmental studies; (e) A companion book that simulates the 1901 Doubleday, Page & Co. publication, updated to address contemporary themes and styles.

AUDIENCE

The audience for the film is the national public television audience, high school and university students and faculty, and museums and organizations. We are developing a proposal for the Alaska Science and Technology Foundation that will produce and disseminate study guide materials and an interactive CD-Rom, and create web sites for the Alaska and national population.

DISTRIBUTION

(a) The Education Project: The film will be designed for broadcast on PBS and will be accompanied by a study guide for secondary and college students. A web site will include interviews with the project participants, the study guide, and a full transcript of the film. Hyperlinks will connect the web site to the extensive Internet material available about the Harriman Expedition. The film's broadcast will be a major media event that will spur interest in history, anthropology, and the nature of scientific expeditions, past and present, and acquaint the viewer with changes in the Native culture and the environment of one fragile location over the course of a century. Outreach plans include the following: (a) Targeted distribution of the film to colleges, secondary schools, state and federal agencies, and individual scientists and citizens; (b) a comprehensive study guide about the Alaskan coast and the issues in the film; (c) a web site with complete information about the film and the expeditions; (d) press kits and marketing materials; (e) broadcast quality master tape available to PBS and national network broadcasters; (f) a CD-Rom that includes all of the educational elements of the project and interactive activities for students and teachers

B. Methods

OVERVIEW

The New Expedition: In 2000 the Harriman Alaska Expedition Retraced project, organized and supported by the Smith College Science Center, will recreate the turn-of-the-century cruise of the George W. Elder. Scientists, naturalists, artists, anthropologists, and historians of the late 20th century will observe anew the sites visited by Harriman's scouting parties a century ago. Since then not only has Alaska changed, but so has the nature of scientific inquiry, sensibilities about the environment, and awareness of indigenous people's rights. In many ways the Harriman Expedition's records are a precious time capsule. The new expedition allows us to open that capsule to a

new perspective and compare not only its contents to what we see on the Alaskan coast today, but also how the old expedition viewed and understood the Alaska of its time.

The project has received a $286,000 grant from the Charles D. Webster Trust to pay for the costs of the 2000 voyage. This grant covers the berths and airfare costs for the modern-day scientists, historians and artists, and for the administrative staff. We have chartered the World Discoverer, a 285', ice-hardened hull cruising ship for the voyage.

The original expedition will give the film its chronological structure. The production will start with Harriman's search for the best scientists, follow the cruise from Seattle to the Bering Straits and back, and end with the thoughts and conclusions of the original expedition members. We will use many of the photographs and hundreds of colored illustrations and paintings produced by Edward Curtis and other expedition members, and live, 16mm color cinematography to compare the old Alaska with the new. We will revisit in detail the sites the original cruise examined and assess the changes in the animal, plant, and human communities. Throughout the film, modern day scientists and historians, both on the new expedition and off, will provide insight and analysis.

ISSUES

Alaska as Symbol: The Exxon Valdez oil spill of 1989 was a seminal event in Alaskan history. It changed Americans' view of the state as a symbol of pristine wilderness to one of a productive but fragile ecosystem. "History, "observes historian William Cronon, "is a long-standing dialogue between human beings and the earth." The Harriman Alaska Expedition Retraced will trace the pattern of this dialogue in Alaska over the past century. In Alaska, some would manage the wilderness to make optimal use of its resources. Others would worship the wilderness, preserving it against desecration. A typical clash over wilderness is often a conflict between two "Goods": a new pipeline that provides funds for the people of an entire state and the aesthetic purity of nature left alone and untamed. Beauty versus utility, nature versus civilization, religion versus science. This project will explore the paired contradictions at the heart of the continuing paradox of Alaska as symbol of both untouched wilderness and productive resource.

A Bench Mark to Assess Our Relationship with the Natural World: The Harriman Expedition provides a bench mark for Americans to assess their relationship with the natural world. The wilderness

of Alaska, as seen through the eyes of the 1899 expedition, is a milestone we can use to assess how far we have come, take stock, and consider where we might be going. The data from the original expedition gives us the rare opportunity to evaluate the influence of human activity on a specific region over a one-hundred-year period. In a way, it is a capsule version of the effect of civilization on the wild places of the earth. The Harriman Alaska Expedition Retraced is a vehicle for examining America's stewardship of its last significant wilderness, and the values, politics, and personalities that have shaped the discussion.

There are two Alaskas: the Alaska of the imagination, the pristine and vast wilderness, and the Alaska of our reality, a resource-rich region that has been developed since its occupation by Russian, Asian, and American interests. Portions of society see this rich land as an economic opportunity and strive to use its resources. Others view the very same landscape and see a natural wonder whose greatest value is in its preservation. This apparent contradiction is at the heart of America's psyche: a deep reverence for wilderness and the spirituality it represents coupled with the desire to exploit it for material gain. These two Alaskas and their constituencies will be explored.

The Changing Nature of Scientific Exploration: The nature of scientific exploration, expeditions, and empirical observation has changed dramatically in the past 100 years, and these changes can be seen by comparing the Harriman Expedition of 1899 with the Harriman Alaska Expedition Retraced of 2000. The Harriman Expedition was as much floating university as expedition. A comparable expedition--a two months survey peopled with artists, poets, writers, and world-renowned scientists--would be next to impossible today. The original expeditioners' observations were determined by their tools and their world view. The Expedition Retraced gives us the opportunity to revisit, with hindsight and refined technology, the discoveries and conclusions made a century ago.

Illumination of Historical Ideas, Figures, and Events: The Harriman Alaska Expedition Retraced will illuminate the lives and significant ideas of those who participated in the expedition and show how their writings and research affected the image of Alaska for the next century. The passengers on the ship were some of the most famous and influential people in America at the time: Edward Harriman, the railroad magnate who financed the trip and wanted more than anything to bag a Kodiak Bear; Edward Curtis, the young photographer who began to document dying Indian cultures on this voyage; Louis Agassiz Fuertes, the brilliant ornithologist who

shot thousands of birds for his collection; John Muir, the naturalist and first president of the Sierra Club, who believed Alaska's dwindling resources could not afford many more such attacks in the name of science; John Burroughs, the nature writer who almost jumped ship when he'd had enough of the rough seas; Charles Keeler, the home-sick poet who was never quite sure why he had been invited along; Bernard Fernow, the German-born, piano-playing forester, who calculated the timber value of the virgin forests; and C. Hart Merriam, the eminent Smithsonian biologist who spent more than a decade organizing the data gathered by the expedition.

SCHEDULE

Timeline: Research, scouting, and preliminary filming will take place over the summers of 1999. Final film will take place in 2000. Educational and outreach materials will be developed in 2000. The film will becompleted in early 2001 and broadcast on Alaska Public Television in spring 2001 and national public television in fall 2001. Support is requested for the research and scouting phase of production.

October 31:	Review research material, scouting notes, and preliminary filming from Summer 1999. Work with ASTF on first CD-Rom.
November - May 30:	Prepare for 2000 Expedition, determine final locations, conduct preliminary interviews,consult with advisors. Complete first draft of Study Guide and Web site.
June 30:	Commence summer 2000 filming
July 10 - August 9:	Retracing of Harriman Alaska Expedition aboard World Discoverer
September- October 31:	Complete all filming for production

B. Project Milestones and Endpoints

December 1997 - February, 1999. Preliminary research, contact prospective participants, write initial proposals, meet with potential funders and scout locations in Alaska. The first location scout was performed in October, 1998.

March - April, 1999. Finalize plans for 1999 filming along the Alaskan coast. Assemble crew, determine final locations, preliminary interviews with scientists and villagers.

May - September, 1999. Filming in Alaska at locations visited by the Harriman Alaska Expedition in 1899.

September, 1999 - April, 2000. Log footage, preliminary assembly of film sections, preparation for year 2000 filming at coastal sites as well as on the modern expedition. Start web site design and study guide.

May - June, 2000. Continue filming at sites along Alaskan coast.

July - August, 2000. Film recreation of expedition aboard ship World Discoverer.

September, 2000. Final filming of locations along Alaskan coast.

October, 2000. Log footage, complete transcripts, and start first assembly. Work with PBS to determine broadcast date. Initial stages of press and outreach campaign. Start work on web site and study guide.

November, 2000 - February 2001. Complete editing first, second and fine cuts of the two hour film. Reviews of film in its rough cut stages by consultants and focus groups.

March - April, 2001. Record music and narration. Begin targeted outreach. Launch web site and finish study guide.

May, 2001. Film is ready for national PBS broadcast.

C. Completion Date

The film will be completed and the educational materials published in FY 01.

PUBLICATIONS AND REPORTS

We do not plan to submit manuscripts for publication in FY 00.

PROFESSIONAL CONFERENCES

Not applicable

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The project has been working with all the relevant agencies in Alaska. Advisors and consultants include Joy Geiselman, USGS; Mike Boylan and George Constantino, Fish and Wildlife Service; Nancy Bird, Prince William Sound Science Center; Janet McCabe, National Park Service and many others.

SUPPORT

Endorsers of the project include Marshall Lind, Chancellor, the University of Alaska, Juneau; Perry Eaton, Alaska Native Heritage Center; Jay Hammond, Former Governor; Walter Hickel, Former Governor; Phoebe Wood, CFO, ARCO/Alaska; Letters from Perry Eaton and Walter Hickel are attached. Letters from the other institutions are pending.

PROPOSED PRINCIPAL INVESTIGATOR

Lawrence R. Hott
Florentine Films/Hott Productions
20 Kingsley Avenue, Haydenville, MA 01039
Tel. 413-268-7934
Fax. 413-268-8300
E-mail: floren@javanet.com

In association with The Clark Science Center, Smith College
Tom Litwin, Director
Smith College
Northampton, MA 01063
Tel. 413-585-3801
Fax. 413-585-3786
E-mail: Tlitwin@science.smith.edu

PRINCIPAL INVESTIGATOR

Qualifications: Lawrence R. Hott, Producer/Director, and Diane Garey, Editor, have been producing films for PBS since 1979. Their first production was the highly acclaimed THE OLD QUABBIN VALLEY, a portrait of a water resource controversy in Massachusetts. Subsequent productions include THE GARDEN OF EDEN, NIAGARA FALLS, THE ADIRONDACKS, and SENTIMENTAL WOMEN NEED NOT APPLY: A HISTORY OF THE AMERICAN NURSE. Hott and Garey have produced three films for The American Experience: BATTLE FOR WILDERNESS, KNUTE ROCKNE AND HIS FIGHTING IRISH, and WILD BY LAW. Their two-part, two-hour seriesTUBERCULOSIS IN AMERICA," aired nationally on PBS in 1995. Their documentary, DIVIDED HIGHWAYS: THE INTERSTATES AND THE TRANSFORMATION OF AMERICAN LIFE premiered nationally on PBS in 1997 and received an Emmy for Outstanding Historical Programming and a George Foster Peabody Award. Their feature-length dramatic film THE BOYHOOD OF JOHN MUIR, which was the Christmas Day Special on PBS in 1998, won the Gold Hugo at the Chicago International Television Festival and the Parents' Choice Gold Award. Their film, THE ACLU, aired on PBS in 1998 and won the Gold Apple at the National Educational Media Competition. Hott was the Fulbright Fellow in Film and Television in the United Kingdom in 1994 and Hott and Garey received the Humanities Achievement Award from the Massachusetts Foundation for the Humanities in 1995. The team has received two Academy Award nominations, and more than one hundred major awards for their film work.

The coordinating director is Thomas S. Litwin. Litwin is the director of the Clark Science Center, Smith College, a multi-million dollar, five building complex housing eight academic departments and eighty faculty. Litwin is the Senior Scientific Advisor for Migratory Birds for the U.S. Fish and Wildlife Service Connecticut River Planning Project. He was the founding director of the Seatuck Research Program, Laboratory of Ornithology, Cornell University. The Harriman Alaska Expedition Retraced is a collaboration of the Smith College Alumnae Association Travel Program and the Smith College Environmental Science and Policy Program.

OTHER KEY PERSONNEL

Anthropologists and Historians:

Steve Haycox, Historian, Department of History, University of Alaska, Anchorage
Claus-M. Naske, Historian, Department of History, University of Alaska, Fairbanks.
Aldona Jonaitis, Director, University of Alaska Museum, Fairbanks
Tom Thornton, Anthropologist, University of Alaska, Juneau
Arthur Petersen, Professor of English, University of Alaska, Juneau
Rosita Worl, Anthropologist, Sealaska Heritage Foundation
Susan Kollin, Professor of English, Montana State University

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$65.0
Travel		$14.8
Contractual		$26.0
Commodities		$20.8
Equipment		$0.0
Subtotal	$0.0	$126.6
Indirect		
Project Total	$0.0	$126.6
Full-time Equivalents (FTE)		1.0
	Dollar amounts are shown in thousands of dollars.	
Other Resources		$549.7

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		$132.7			

00418

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2000
	Lawrence Hott	Producer/Director	3.0	7.5		22.5
	Diane Garey	Production Assistant	3.0	2.5		7.5
		Cinematographer	2.0	9.0		18.0
		Sound Recorder	2.0	4.5		9.0
		Assistant Camera	2.0	4.0		8.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	12.0	27.5	0.0	
					Personnel To	$65.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2000
	Airfare, to and from Alaska, plus float plane to various locations	2.1	4		8.5	8.5
	Van Rentals			20	0.1	2.5
	Meals: 5 people x 10 days @ $50/per Evos portion is $1250			10	0.1	1.3
	Hotels: 5 people x 10 days @ $100/per day. Evos portion is $250			25	0.1	2.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$14.8

Prepared: 03/26/99

Contractual Costs:	Proposed
Description	FY 2000
Process Film Negative, 50,000 feet at $.21 per foot	10.5
Camera Rental, 20 Days @ $400 per day	8.0
Sound Rental, 20 Days @ $375 per day	7.5
Contractual	$26.0

Commodities Costs:	Proposed
Description	FY 2000
Production Supplies: gaffers tape, film cans, waterproofing, packing gear	1.0
Film Stock, 100 rolls @$132 per roll	13.2
Audio Tape, 20 rolls @ $8.75 per roll	0.2
Film to Tape Transfer, 17 hours @$375 per hour	6.4
Commodities	$20.8

Prepared: 03/26/99

New Equipment Purchases:			
Description	Number of Units	Unit Price	Proposed FY 2000
			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 Equipm**	$0.0

Existing Equipment Usage:		
Description	Number of Units	

Prepared: 03/26/99

Project Title: Patterns and Processes of Population Change in Selected Nearshore Vertebrate Predators

Project Number:	00423
Restoration Category:	Research and Monitoring
Proposers:	Jim Bodkin, Dan Esler, Brenda Ballachey, and Tom Dean
Lead Trustee Agency:	DOI
Cooperating Agencies:	
Alaska Sea Life Center:	Yes
Project Duration:	2nd year, 5-year project
Cost FY 00:	$284,900
Cost FY 01:	$392,600
Cost FY 02:	$345,100
Cost FY 03:	$222,590
Geographic Area:	Prince William Sound
Injured Resource/Service:	Sea Otter, Harlequin Duck

ABSTRACT

Sea otters and harlequin ducks have not fully recovered from the EVOS, based on population-level demographic differences between oiled and unoiled areas. Further, in oiled areas, both species show elevated cytochrome P4501A (CYP1A), almost certainly reflecting continued exposure to oil. We propose to explore links between oil exposure and the lack of population recovery, with the intent of understanding constraints to full recovery of these species and the nearshore environment generally. We also will monitor the progress of recovery of the species and the system. Sea otter work includes aerial surveys of distribution and abundance, estimation of abundance and sizes of green sea urchins, measurement of CYP1A, and evaluation of survival and movements. Harlequin duck work consists of field and captive bird components. Field studies will examine the relationship between survival and CYP1A and, further, will serve to monitor these key parameters. Captive experiments will examine the relationships between oil exposure and CYP1A induction, and metabolic and behavioral consequences of exposure.

INTRODUCTION

The nearshore environment of Prince William Sound (PWS) received about 40% of the oil spilled after the *Exxon Valdez* ran aground (Galt et al. 1991). Concerns about nearshore recovery and restoration have resulted in a suite of studies sponsored by the Exxon Valdez Oil Spill Trustee Council, including the Nearshore Vertebrate Predator project (NVP). Principal findings of NVP include an apparent lack of population recovery for sea otters (*Enhydra lutris*) and harlequin ducks (*Histrionicus histrionicus*), both invertebrate feeders in the nearshore ecosystem. Over a three year period, harlequin ducks residing in oiled areas had poorer survival than those in unoiled areas. Although survival rates were not directly obtained for sea otters, inferences based on capture data suggest increased mortality (or higher rates of emigration) for sea otters in oiled areas compared to their counterparts in unoiled areas. Further, both species show evidence of continuing exposure to *Exxon Valdez* oil, based on higher levels of cytochrome P4501A (CYP1A) induction in oiled areas than unoiled. Elevations in CYP1A are not due to background or natural hydrocarbon sources, as these were found to be negligible in intertidal areas of PWS (Short and Babcock 1996). NVP studies also found that elevated CYP1A induction in oiled areas was not due to area differences in PCB exposure, leaving continued exposure to residual *Exxon Valdez* oil as the most plausible explanation. Residual oil is still stranded in intertidal areas of PWS (Babcock et al. 1996).

Conceptual links have been drawn describing mechanisms by which oil exposure could have population-level demographic impacts on these species. However, these links, and thus the processes that may limit full recovery, remain speculative. Therefore, we propose building on the base of knowledge gained through previous research to (1) explore the relationships between oil exposure and demographic attributes that could have population level effects, and (2) monitor the parameters identified in previous work that are most effective and statistically powerful in describing population status and that also lend insight into the process of recovery of sea otters and harlequin ducks, and the nearshore environment generally.

Sea Otters

The NVP study provided several lines of evidence indicating that sea otters in the most heavily oiled portions of western Prince William Sound (WPWS), at northern Knight and Naked islands, have not recovered from oil-related injury (Holland-Bartels et al. 1997, 1998). The sea otter population at northern Knight has not increased between 1993-98 (the period for which we have aerial survey data), with numbers remaining at about half the estimated pre-spill abundance. Demographic data suggest that reduced survival among residents and/or higher emigration from the oiled area are restricting growth of the population. Levels of CYP1A are higher in sea otters from Knight Island than from unoiled reference areas, suggesting continued exposure to residual oil may be affecting recovery of the species. Additionally, increased proportions of large individuals of several sea otter prey species were identified at northern Knight, consistent with reduced predation and lack of recovery of the sea otter population in that area.

The sea otter component of this proposal builds on previous EVOS research (93045, 95025-99025) to develop a statistically sensitive and cost-effective program that will continue to track the WPWS sea otter population and nearshore ecosystem recovery. We will address four questions: (1) are sea otters increasing in abundance in the most heavily oiled areas, and in western PWS overall? (2) what are the ecological interactions between sea otters and green sea urchins, a preferred invertebrate prey of sea otters? (3) is there continuing evidence of oil exposure, and is this exposure declining over time?, and (4) are elevated mortality and/or emigration rates of sea otters in oiled areas limiting recovery of the population?

For FY2000, we propose continued aerial surveys of sea otter abundance at appropriate intervals to monitor the population and test predictions of a previously developed sea otter population model (Restoration study 99043; Udevitz et al. 1996). We will also monitor abundance and size of intertidal green sea urchins, a key invertebrate species, which will allow an independent assessment of sea otter recovery through predicted responses in a prey population. These elements are a continuation of work proposed and approved in 1998, and initiated in Project 99423.

We propose two additional components of work for sea otters for FY2000. The first is the continued tracking of CYP1A in sea otters from oiled and unoiled areas, as a biomarker of hydrocarbon exposure, and comparison of CYP1A levels with results from 1996-98. The second is a "mark-recapture" study, through tagging and subsequent visual relocations of sea otters, to assess mortality and emigration as factors limiting growth and recovery of the population in oiled areas.

We propose to conduct the sea otter aerial surveys, CYP1A monitoring and mark-resighting program again in FY2001. In FY2002, we will conduct aerial surveys, monitor sea urchins abundance and size, and conclude the resightings of tagged sea otters. The only field work planned for FY 2003 is an additional aerial survey. A final report will be prepared in FY2003 in conjunction with the harlequin duck component of the study. Information obtained from the proposed research will be valuable for differentiating between demographic and health-related causes for the current lack of recovery in the WPWS sea otter population as well as aiding our understanding of processes involved in recovery of the nearshore system to major perturbations such as the EVOS.

Harlequin Ducks

The most concerning result from NVP harlequin duck studies was the detection of significantly lower survival probabilities of adult females in oiled areas of PWS (76.6%) than in unoiled areas (86.6%). Analyses revealed that history of oil contamination was a more likely explanation for the survival difference than intrinsic differences between oiled and unoiled study areas. Further, projections of population trends using models incorporating these survival probabilities predicted declining populations on oiled areas and increasing populations on unoiled areas. This pattern was observed during Alaska Department of Fish and Game surveys (EVOSTC Project /427), suggesting that differences in survival were a likely mechanism for observed differences in

population trends. Also, harlequin duck densities were lower on oiled Knight Island than on unoiled Montague Island, after accounting for intrinsic habitat differences; this is the pattern that would be predicted given high site fidelity and poorer survival on oiled areas. Finally, higher levels of CYP1A induction were detected on oiled areas.

Results from these recent harlequin duck studies lead to speculation that continued exposure to oil could result in poorer survival of harlequin ducks, which in turn would result in differences in population trends and densities. There are reasonable explanations for how oil may be related to survival (see Statement of Problem below). Unfortunately, however, these links are drawn from a wide array of sources, with limited inference to wild harlequin ducks in PWS. Thus, we propose studies that will explore the relationship between oil exposure and survival using both field and captive bird approaches. These will serve to examine mechanisms or processes that may continue to limit harlequin duck population recovery. These studies also will monitor the most critical elements revealed in previous studies to gauge the progress of recovery.

The specific questions that will be asked by the harlequin duck components of this study are: (1) what is the relationship between levels of oil exposure and CYP1A induction, and what levels of oil exposure result in CYP1A values similar to those measured in PWS? (2) are there metabolic or behavioral consequences of oil exposure that could be a mechanism by which harlequin duck survival is compromised? (3) is oil exposure (as indicated by CYP1A induction) related to survival of harlequin ducks in the wild? and (4) is contaminant exposure declining over time and, similarly, are survival rates on the oiled area improving through time? Questions 1 and 2 will be addressed using captive birds at the Alaska Sea Life Center during winters 2000-01 and 2001-02. Questions 3 and 4 will be addressed by biosampling and radio telemetry work during winters 2000-01, 2001-02, and 2002-03. This work will examine both the process of recovery (through understanding of the mechanisms constraining population demography) and will monitor the progress of recovery by sampling survival and CYP1A induction of wild birds starting 3 years subsequent to the last work done as part of NVP (winter 1997-98). Proposed survey work by the Alaska Department of Fish and Game would aid interpretation of field studies and would also monitor population recovery.

NEED FOR THE PROJECT

A. Statement of Problem

Sea otters and harlequin ducks occupy an invertebrate-consuming trophic level in the nearshore and are conspicuous components of the nearshore ecosystem. In 1995, the NVP Project was initiated to examine the status of recovery of nearshore vertebrates (including sea otters, harlequin ducks, river otters and pigeon guillemots), and to examine possible causes for the apparent lack of recovery. Results of the NVP project clearly suggest that complete recovery has not occurred for sea otters and harlequin ducks, and the lack of recovery may be related to continued exposure to oil. This proposed work follows up on the critical elements revealed by

the NVP studies, in particular the relation between population status and oil contamination, and evaluation of population status.

In addition to observations made directly on predator species, as part of the NVP project, we have observed an apparent response among several invertebrates to reduced sea otter densities. This finding represents a shift in the ecological processes structuring the nearshore community and provides a unique opportunity to test predictions related to sea otter recovery and their prey. We also have an opportunity to test the application of this novel approach as a tool for monitoring predators through prey that may have broader ecological applications.

Sea Otters

The sea otter population in WPWS was injured as a result of the spill. Estimates of sea otter mortality due to the spill range from 750 to 2,650 individuals (Garshelis 1997, Garrott et al. 1993). A population model (Udevitz et al. 1996) predicted recovery of the WPWS sea otter population in 10 to 23 years, projecting maximum annual growth rates from 0.10-0.14. Surveys to date (1993-1998) have shown a significant increasing trend in the WPWS sea otter population, averaging about 10% per year since 1993 (power > 0.80 to detect a 1% annual change in 5 annual WPWS surveys). In contrast to the western Sound overall, at northern Knight Island, sea otter numbers remain below pre-spill estimates and do not show a significant increasing trend (Fig. 1; Holland-Bartels et al. 1998), although our power to detect change is lower for these surveys.

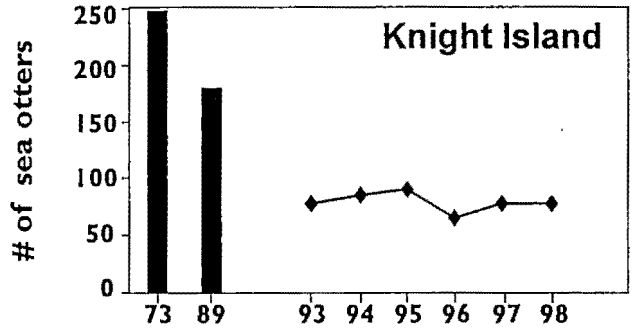

Figure 1. Estimated sea otter abundance at northern Knight Island.

Aerial survey data of sea otter abundance have provided the foundation for assessment of recovery status in WPWS. However, pre-spill data of abundance are few, and there are known biases in pre-spill estimates that preclude using pre- vs. post-spill comparisons in making a definitive quantitative assessment of the extent of recovery. Furthermore, recovery status could not be based solely on post-spill comparisons of oiled and unoiled areas because there are recognized differences in habitat between these areas, and it is uncertain whether sea otters in oiled areas could ever achieve population densities observed in unoiled parts of the Sound. As a result, in the NVP study, we examined prey populations as an ancillary means of assessing recovery.

This approach was based on the knowledge that sea otters have a profound and predictable effect on the structure of prey populations (reviewed in Riedman and Estes 1990). Generally, as sea otters reoccupy an area, they first consume the largest members of the most energetically profitable prey, eventually switching to smaller sizes and different species, as preferred species

and the larger size classes become rare (Estes and Palmisano 1974, Duggins 1980, Estes and Duggins 1995). Based on the work summarized above, we hypothesized that a reduction in otter abundance would be accompanied by an increase in the abundance and average size of prey. We concluded that the status of recovery of impacted populations of sea otters might therefore be assessed by examining the abundance and size-distributions of prey within impacted areas, and by comparing these with estimates from an unaffected area where otters and their prey were considered to be in equilibrium. Full recovery would be indicated by similar abundances and size distributions of prey in oiled and unoiled areas.

NVP comparisons of most invertebrate prey populations between Knight Island (oiled) and Montague Island (unoiled) identify differences in prey population structure consistent with lack of recovery of the sea otter population at the oiled site (Holland Bartels et al. 1998). At the sites where sea otter populations were greatly reduced, we have found significantly greater proportions of large individuals among most species of clams, urchins and mussels. Continued prey assessment provides a unique opportunity to complete the testing of an innovative approach for estimating the status of a predator population. When sea otter populations near complete recovery, we predict that differences in prey sizes between areas should diminish. We propose to continue monitoring the abundance of sea otters and the size and abundance of sea urchins in oiled and unoiled areas of WPWS to assess the recovery status of sea otters. These components of the proposal were approved for FY99, and will be implemented this summer. (Additional research components for sea otters, described below, are proposed following our examination of the most recent NVP sea otter data, collected in the 1998 field season.)

In consideration of the lack of increase in sea otter numbers at Knight Island, we analyzed the sea otter capture data from 1997 and 1998 as a "mark-recapture" experiment. Sea otters were captured and tagged with numbered, color-coded flipper tags each summer, from 1996-98. Consequently, in the second and third years ('97 and '98) of capture operations, we had the potential to recapture animals that had been tagged in previous years. We computed the expected number of recaptures for each year, based on the total number of sea otters in each study area and the number of otters tagged in the previous year(s), and compared this to the actual number of recaptures (Table 1). In the oiled area, actual recaptures comprised only 25% of the expected number in 1997, and 27% of expected in 1998. In contrast, in the unoiled area, we recaptured 64% of the expected number in 1997, and 63% in 1998. This difference between areas indicates that sea otters in the oiled area are not available for recapture in the proportions expected, suggesting either that they are dying or emigrating from the study area at a greater rate than are otters at Montague.

Table 1. Mark-recapture data for sea otters caught in oiled and unoiled areas, 1996-98.

Year	Pop'n Size[a]	Number Captured & Marked	Proportion Marked	Number Recaptured	Expected Number Recaptured[b]	Ratio of Actual to Expected Recaptures
Oiled - Knight						
1996	65	30				
1997	76	17	0.395	2	7.89	0.25
1998	76	19	0.618	4	14.84	0.27
Unoiled - Montague						
1996	382	29				
1997	595	28	0.049	1	1.56	0.64
1998	623	34	0.091	2	3.20	0.63

[a] From aerial surveys

[b] Assuming no mortality and no emigration

A major finding of the NVP study was elevated levels of CYP1A in 5 different species that inhabit the nearshore in oiled areas of WPWS, providing compelling evidence of continued exposure to residual EVOS oil. Sea otters were sampled in 1996-98, and in all three years, animals from Knight and Naked islands had elevated CYP1A, compared to those from the Montague study area (Table 2). Further, based on the pattern of CYP1A induction in sea otters from oiled areas (i.e., a high proportion of individuals with elevated levels in each of the three years), we can infer that exposure is generally continuous and prolonged. Sea otters from the unoiled study area have much lower CYP1A levels, similar to those measured in otters from a relatively clean area in southeast Alaska with no known exposure to oil or other contaminants. In 1998, the mean value of CYP1A in the oiled study area was lower than means for 1996 or 1997, due to the lack of any individuals with relatively high values in 1998 (see ranges in Table 2). This decline may indicate diminishing exposure to residual oil over the course of the NVP study, and continued monitoring is warranted to determine if CYP1A induction is indeed decreasing.

Table 2. Expression of CYP1A in sea otter lymphocytes, measured by RT-PCR (units are numbers of molecules of CYP1A mRNA x 10^6 per 100 ng total RNA).

Year	Oiled Area *(Knight & Naked)* n	Mean & SD (Range)	Unoiled Area *(Montague)* n	Mean & SD (Range)
1996	22	28.9 +/- 35.1 (5.6 - 155.9)	22	1.18 +/- 0.5 (0.4 - 2.3)
1997	26	38.6 +/- 61.8 (0.65 - 228.85)	29	1.92 +/- 2.6 (0.06 - 10.5)
1998	23	13.1 +/- 1.7 (5.54 - 39.66)	35	1.36 +/- 0.4 (0.32 - 14.81)

The issue of biological significance of CYP1A induction for sea otters and other nearshore vertebrates has been difficult to address. At capture, sea otters in both oiled and unoiled areas are in apparent good condition, with no indications of adverse health. Analyses to date of blood data generally show few differences between otters in the two study areas. However, elevated levels of GGT, a serum enzyme associated with the liver, have been noted in oiled areas and may indicate hepatic dysfunction. Although the GGT differences between areas are not major, they are statistically significant ($P<.002$) over the 3 year study period, and may signal a functional change in the otters. These observations are consistent with a 1992 study which demonstrated elevated GGT in sea otters from oiled areas of WPWS (USGS unpublished data), and perhaps with earlier observations of liver and kidney pathologies in sea otters exposed to oil in 1989 (Lipscomb et al. 1993, 1994). In 1996-98, however, GGT levels are lower than in 1992, perhaps suggesting that individuals with the greatest degree of organ damage are no longer in the population.

At this time, we cannot rule out a link between continuing exposure to residual hydrocarbons and a lack of recovery of the sea otter population in oiled areas. Surveys to monitor population growth rates, and incorporation of a mark-resighting study to obtain estimates of survival and emigration rates for individual sea otters with known CYP1A and GGT levels, will allow us to assess adverse health effects related to oil exposure as a mechanism limiting recovery of sea otters.

In summary, continued monitoring of sea otter distribution and abundance, prey populations, hydrocarbon exposure and mortality/emigration rates in WPWS will be valuable in (1) providing insight into potential demographic constraints to recovery which may improve future recovery models, (2) documenting actual recovery time for the nearshore system including sea otters, and (3) providing long-term population trend data which may be used in assessing initial damage and subsequent recovery of sea otter populations in the event of future oil spills.

Harlequin Ducks

Harlequin ducks were, and remain, particularly vulnerable to deleterious effects of the oil spill. Much of the oil from the *Exxon Valdez* was deposited in the nearshore intertidal and shallow subtidal zones (Galt et al. 1991), the coastal habitats where harlequin ducks occur. Also, Goudie and Ankney (1986) suggested that harlequins were near the lower limit of body size for sea ducks occurring in environments similar to Prince William Sound in winter. Because harlequin ducks exist close to an energetic threshold, any perturbation (e.g., an oil spill) that either affects health or condition directly (via toxic effects or increased metabolic costs) or indirectly (via food abundance) could have significant consequences for the population.

Also, among ducks, sea duck life histories are particularly K-selected (Eadie et al. 1988). Harlequin ducks typically defer reproduction for 3 years, have relatively low annual investment in reproduction, and are long-lived (Goudie et al. 1994). Species with these characteristics have relatively low potential rates of population change and, thus, following a perturbation such as an oil spill, require many years in the absence of continued adverse effects to recover to previous population levels. Further, population dynamics of animals with this life history strategy are particularly sensitive to adult survival (Goudie et al. 1994, Schmutz et al. 1997).

Sea ducks have a general pattern of high philopatry throughout their annual cycle (e.g., Limpert 1980, Savard and Eadie 1989) and harlequin ducks follow this pattern, having high fidelity to molting and wintering sites (Robertson 1997; Esler, unpubl. data). High site fidelity could result in vulnerability to population effects because: (1) if residual oil spill damages exist, birds from oiled areas are vulnerable to spill effects as they return to those areas annually (i.e., these birds are affected disproportionately and are subject to cumulative effects), and (2) if dispersal and movements among areas are limited, recovery of groups of birds in oiled areas can occur only through demographic processes specific to that group (i.e., numbers are not enhanced through immigration from other areas). High site fidelity is an adaptive behavioral strategy in natural situations and predictable environments (Robertson 1997), but does not accommodate movement to undisturbed sites in the face of human-caused perturbations.

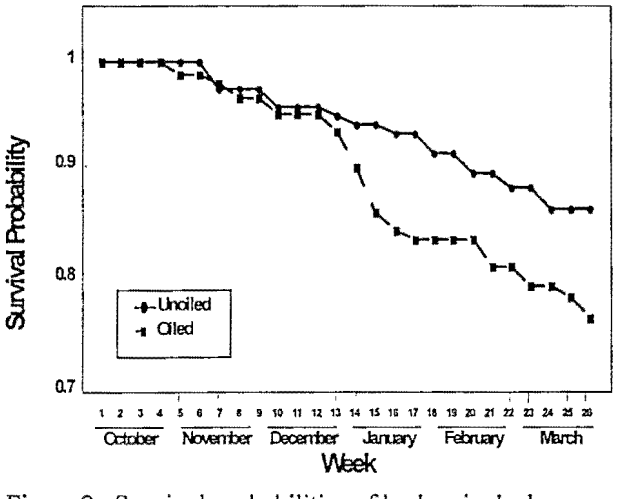

Figure 2. Survival probabilities of harlequin ducks.

Evidence from recent studies (NVP and /427) suggests that, as might be predicted from their vulnerability, harlequin duck populations have not fully recovered and, in fact, continue to suffer deleterious effects from the oil spill. Over the course of 3 winters, survival probabilities differed between oiled and unoiled areas (Figure 2). Survival probabilities were high, and similar between areas, in fall. However, survival diverged between areas during mid-winter, presumably the period during which conditions are most

difficult for harlequin ducks. Also, differences in CYP1A induction were detected between populations from oiled and unoiled areas (although this was measured on different birds than those for which survival data were collected). Further, body mass during winter showed a slight, negative relationship with CYP1A level.

One can speculate on mechanisms by which continued exposure to oil could be related to differences in survival probabilities. Most lab studies have shown that mallards are tolerant of internal ingestion of oil, with toxic effects not evident until very high doses. These studies have been used to suggest that harlequin ducks should, similarly, be unaffected by residual Exxon Valdez oil (Stubblefield et al. 1995, Boehm et al. 1996). However, other studies have found that, with addition of other stressors such as cold temperatures, oiled ducks in the lab suffered considerably higher mortality than unoiled (Holmes et al. 1978, 1979). This seems to be a much more appropriate analog for wild harlequin ducks. Particularly given their vulnerability to spill effects and hypothesized existence near an energetic threshold, harlequin ducks may not be able to handle additive effects of the oil spill, even if relatively small.

To fully understand the process of harlequin duck population recovery from the oil spill, it is important to address these speculated links between oil exposure and survival probabilities, and subsequently population trends. The research proposed here is designed to explore these potential mechanisms constraining population recovery. Further, because of their susceptibility to spill effects and high site fidelity, harlequin ducks are an ideal species for monitoring recovery of the nearshore environment.

B. Rationale/Link to Restoration

Sea otter and harlequin duck restoration requires assessments of population recovery status and definition of impediments to recovery. The research components proposed herein represent a comprehensive approach to understanding the factors that affect population dynamics and definition of critical bottlenecks to recovery. Without an understanding of the underlying processes that dictate population change, we can not prescribe specific activities to enhance recovery. Additionally, the proposed work incorporates monitoring activities which, given the "baseline" data collected in NVP and other post-spill studies, will allow us to gauge recovery status of sea otters and harlequin ducks.

Sea Otters

Recovery of sea otters will be complete when population size returns to estimated pre-spill abundance, and there is no further evidence of continuing exposure to residual oil. Sea otter restoration requires an understanding of population status and the processes affecting changes in population status. Differential survival and/or emigration rates in oiled and unoiled areas, which will be addressed in the mark-resighting component, may be a primary factor limiting growth of the population in oiled areas. Continued monitoring of sea otter distribution, abundance, prey populations and CYP1A levels in WPWS will provide insight into demographic constraints to recovery and improve future recovery models, and potentially allow us to document the actual

recovery time for the nearshore system, including sea otters. A further benefit of this work is provision of long-term population trend data which may be used in assessing initial damage and subsequent recovery of sea otter populations in the event of future oil spills.

Harlequin Ducks

Harlequin duck restoration will be complete when densities have recovered to prespill levels and birds no longer show evidence of oil contamination. Poor survival in oiled areas is the most plausible cause for lack of recovery to prespill densities; restoration requires an understanding of the factors that affect survival rates, in particular the effects of oil exposure. This project directly addresses the restoration objectives for this species both by examining the processes affecting recovery and by monitoring the progress of recovery, in particular contaminant exposure.

C. Location

Studies will be conducted in PWS. Specific study sites for the sea otter components will be northern Knight Island and Port Chalmers/Stockdale at Montague Island, as used in the NVP project, to capitalize on previously collected data and populations of marked individuals. Harlequin duck study sites also will be those used in previous NVP work: unoiled, Montague Island and oiled, Green Island, Crafton Island, Main Bay and Foul Bay.

Communities affected by the project include Chenega, Whittier, and Cordova.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The project will continue to inform and coordinate our community involvement activities, including the collection of indigenous knowledge with Dr. Henry Huntington, TEK specialist Chugach Regional Resources Commission and Hugh Short, Community Coordinator, EVOS Restoration Office. We will continue to solicit advice from the above parties and gather information on TEK through synthesis workshops, local community facilitators, and residents.

Efforts have and will continue to be made throughout the restoration process to participate in and provide public involvement in the design and implementation of this project. Information gathered from this project will be shared with local communities. Project staff has and will continue to present information to local communities or prepare articles or photographs for Trustee Council publications. Boat and air charter contracts, and other services will be contracted from local sources when possible. For the sea otters mark-resighting component of the study, we will inform local residents and the Alaska Sea Otter Commission of the presence of tagged animals, and the value to us of reports on locations of tagged otters that they may observe.

PROJECT DESIGN

A. Objectives

Sea Otters

1. Estimate of sea otter abundance and population trends over time in WPWS overall, and in oiled and unoiled study areas within WPWS.

2. Estimate abundance and size class composition of green sea urchins in oiled and unoiled study areas.

3. Estimate mortality and/or emigration rates of sea otters in oiled and unoiled study areas.

4. Measure CYP1A induction in otters from oiled and unoiled study areas as a means to monitor continued exposure to residual oil.

Harlequin Ducks

Field Studies

1. Estimate winter survival rates of harlequin ducks in relation to area (history of oil contamination) and indices of oil exposure (CYP1A induction).

2. Monitor progress of harlequin duck population recovery via tracking of survival rates and CYP1A induction in oiled and unoiled areas.

Captive Bird Studies

1. Measure the CYP1A response in oil-dosed, captive harlequin ducks.

2. Quantify the metabolic and behavioral consequences of oil exposure.

B. Methods

Sea Otters

The proposed sea otter work employs aerial surveys to track population abundance and growth, sampling of intertidal green sea urchins to assess sea otter-prey interactions, monitoring of CYP1A in sea otters as a measure of continuing oil exposure, and a mark-resighting program, using tagged otters to estimate relative survival and/or emigration rates of sea otters in oiled and unoiled areas. This combination of approaches will provide an understanding of links among oil

exposure (as indicated by CYP1A induction), survival rates and movements, and recovery status of the population, assessed by growth rates and prey structuring.

Sea otter population monitoring--We will continue to use previously developed aerial survey techniques which employ counts along systematic transects, and intensive search units (ISU's) to estimate a correction factor for each survey (Bodkin and Udevitz, in press). We will conduct a single survey of the entire WPWS every two years beginning in 2000, and continue annual replicate surveys (5 or more replications per survey) of the smaller NVP study sites, beginning in 1999. In 1999, a Sound-wide survey will be conducted to provide a 5 year estimate of PWS sea otter abundance. Bi-annual WPWS surveys do not diminish our power to detect population changes in the greater WPWS area. However, increasing replicate survey intervals for the smaller NVP study areas greatly reduces our power to detect changes. It may require 8 years of annual replicate surveys (ie., 4 additional years beginning in 1999) to provide adequate power to detect a minimum of a 6% annual increase. The time required to detect this same change may extend to 12 years if the survey interval is increased to every two years (3 additional surveys). In years 2001 and 2003, additional replicates will be conducted to increase power to detect change within replicate survey areas.

Invertebrate prey population monitoring--In 1999, 2000, and 2002 (no sampling planned for 2001 or 2003) we will focus on sampling intertidal populations of green sea urchins (*Strongylocentrotus droebachiensis*). We selected this species because they are a preferred sea otter prey and have populations that are centered in the intertidal zone and can therefore be sampled efficiently, providing adequate power to detect change.

Sampling will be conducted from within Herring Bay and Bay of Isles on Knight Island, and along the Stockdale Harbor and Port Chalmers portions of Montague Island. Density estimates will be obtained from systematically selected transects along the shorelines in each area. For sea urchins, size distribution data will be supplemented by sampling in preferred sea urchin habitats. The details of site selection and sampling methods are given in Holland-Bartels et al. (1998).

Recovery of sea otter populations will be assessed by comparing the size distributions and biomass of sea urchins at Knight Island vs. Montague Island. A lack of significant differences between oiled and reference (unoiled) sites would be indicative of recovery. The data from 1999 will be combined with similar data from 1996-1998 to assess possible trends in recovery, as indicated by converging size distributions and abundances at the two sites.

Cytochrome P450 1A--In summers of 2000 and 2001, we will capture 60 sea otters in oiled and unoiled areas (30 per area per year). We will capture in the same locations (Knight and Montague islands) that were sampled in the NVP project so that additional data collected can be directly compared to previous (1996-98) results. Capture and handling methods will be similar to those employed previously (Holland-Bartels et al. 1998). Sea otters will be sedated, body measurements taken, a tooth collected for age determination, and a blood sample taken by jugular venipuncture. Each otter will be tagged with two color-coded, numbered flipper tags. Following reversal, sea otters will be released in the same vicinity as captured.

In the NVP study, the RT-PCR assay (quantitative reverse transcriptase PCR assay; Van den Heuvel et al. 1993, Snyder et al. unpub. ms) was adapted to measure CYP1A levels in sea otters. This assay quantifies the messenger RNA (m-RNA) that codes for the CYP1A protein. Initially, the RT-PCR assays required the isolation, cloning and sequencing of the PCR product, and the development of sea otter specific primers for CYP1A (Holland-Bartels et al. 1998; Snyder et al. in prep.); that work is now complete. Results of the assay are reported as the number of molecules of mRNA per 100 ng of RNA. We will continue to use peripheral blood mononuclear cells collected from live otters for the assay. The peripheral blood lymphocytes will be isolated by a ficoll gradient technique, cryopreserved in liquid nitrogen and shipped to Dr. Paul Snyder at Purdue University for analyses. In addition, an aliquot of blood from each otter will be processed to obtain serum, which will be frozen and later submitted for serology analysis.

Mark-Recapture--We will conduct a "mark-recapture" study to estimate mortality and/or emigration rates; however, we will utilize a system of visual resightings rather than actual recaptures to enumerate the number of tagged individuals remaining in the population in the oiled and unoiled study areas. Traditionally, mark-recapture studies are used to estimate population size. However, for sea otters in this study, population size will be estimated independently from the aerial surveys. Also, we will have a known number of "marks" (i.e., tagged otters) in the population. Thus, we can compute an expected number (and proportion) of tagged otters that will be seen out of the total number viewed during a resighting effort. Our "recaptures" are derived from the actual visual counts of tagged and non-tagged sea otters (taken after specified time intervals); these will provide an observed number (proportion) of tagged otters remaining in the population. The ratio of the observed to expected proportions can be interpreted as an estimate of "survival" rate for the population, with differences between the observed and expected proportions indicating either mortality or emigration of otters from an area. We hypothesize that the relative ratio of observed to expected resightings should be similar in oiled and unoiled study areas if there are no differences in mortality or emigration of otters from those areas. Examination of 1997 and 1998 capture data suggests that the observed and expected capture ratios are not similar in the oiled and unoiled study areas (Table 1), with relatively fewer sea otters being recaptured, compared to the expected number, in the oiled area.

We will utilize existing tags (unique color/position to allow identification of individuals), put on sea otters captured for NVP in 1996-98, to get initial estimates of survival and emigration of animals in the oiled area during the winter of 1999-2000. Visual counts for this segment of the program will be obtained in late fall 1999 and again in early spring 2000. Additional tags will be put out in the summers of 2000 and 2001: sea otters captured for CYP1A sampling will be tagged (again with unique color/positions) so that they can be resighted and identified from a distance.

We will conduct visual counts to get a resighting rate in late summer 2000 (work conducted in conjunction with the harlequin duck capture to provide savings on charter costs), in early winter 2000 (again, in conjunction with the harlequin duck winter capture effort), and in late winter/early spring 2001 (winter being the period of highest mortality for sea otters in PWS, [Johnson 1987]). Resightings of tagged otters will obtained by two teams of two persons each,

using Questar spotting scopes and binoculars to observe sea otters and count the number of tagged and untagged animals observed within each area. Teams will work concurrently and be in continuous communication to ensure non-tagged otters are only included once in each visual count. Based on sea otter recapture rates in 1997-98 (Table 1), we compute that we will need to observe approximately 50% of the population in each area (about 300 at Montague and 30 at Knight) to detect significant differences between the areas.

We will be unable to distinguish between mortality and emigration for sea otters that are not resighted in a study area. If the ratio of observed to expected resightings differs between study areas, we will endeavor to locate sea otters outside the study areas. Sighting tagged animals outside our study areas may allow us to distinguish emigration, but if animals are not resighted, we cannot then differentiate between mortality and emigration. However, the effect of either mortality or emigration on population growth is similar, and if these demographic processes are occurring at a higher rate in the oiled area, recovery of sea otters will be constrained.

Harlequin Ducks

The proposed harlequin duck work employs both field studies and experimental work with captive harlequin ducks at the Alaska Sea Life Center. This represents an ideal solution to the need for controlled work to look explicitly at the effects of oil exposure on hypothesized mechanisms of mortality and field work to document the relevance of those mechanisms under wild conditions. With captive bird studies, given the hypothesis that harlequin ducks are near an energetic threshold (i.e., do not have the capacity to increase daily energy expenditure or decrease daily energy intake), we propose quantifying metabolic and behavioral responses to known regimes of oil exposure. Also, captive studies will indicate the level of oil exposure that corresponds to CYP1A induction detected in the field. Field studies are necessary to understand the relevance of these relationships to animals in the wild, i.e., understand the link between oil exposure (as indicated by CYP1A induction) and survival probabilities. Also, field studies are required to monitor population and system recovery.

Field Studies

The key data for field studies are paired CYP1A and survival data, which will allow for explicit tests of the hypothesis that mortality and oil exposure are related in wild harlequin ducks. We intend to collect survival and exposure data from 50 birds in each of 3 years by capturing them during early winter, conducting surgeries to both implant transmitters and biopsy livers, and monitoring subsequent winter survival. These types of data have been successfully collected during NVP studies.

This research requires capture of flighted harlequin ducks during early winter, after they have been on wintering sites long enough to be potentially exposed to residual oil, yet before the mid-winter period when survival probabilities diverged during NVP studies (Figure 2). The mid-winter period is presumably the time of greatest stress and thus the period when oil spill effects would be most likely to be expressed as differences in survival probabilities. The interval between capture and the critical mid-winter period must allow for at least a 2-week censor period

to ensure that survival data are not biased by effects of capture, handling, or surgery (Esler et al., unpubl. ms., Mulcahy and Esler 1999). Thus, we propose capturing birds during a 3-week period in November to generate both survival data and exposure data from the same individuals.

We will use floating mist nets (Kaiser et al. 1995) to catch flying birds in oiled (Knight Island, Green Island, Crafton Island, Main Bay, Foul Bay) and unoiled (Montague Island) study areas. Use of the same study areas as the NVP project allows for direct comparisons of results. The floating mist net capture technique was used successfully during NVP studies. However, this technique does not allow handling of as many birds as molt drives, so age and sex cohorts used in survival estimation will not be as restricted as in NVP studies. We will radio birds of both genders and all age classes older than hatch-year. Age and sex parameters will be included in all analyses to account for any survival differences due to these effects. Captured birds will be banded with uniquely coded USFWS bands, aged by bursal probing (Mather and Esler 1999), and sexed by plumage characteristics.

To estimate survival probabilities of harlequin ducks, we will use implantable radio transmitters with external antennas (Korschgen et al. 1996). Implanted transmitters have been successfully used in waterfowl studies (e.g., Olsen et al. 1992, Haramis et al. 1993), and an increasing body of literature suggests that radio transmitters implanted into wild waterfowl are less disruptive than external methods of attachment, based on differences in survival or return rates (Ward and Flint 1995, Dzus and Clark 1996), behavior (Pietz et al. 1993), and reproductive rates (Pietz et al. 1993, Rotella et al. 1993, Ward and Flint 1995, Paquette et al. 1997), especially for diving ducks (Korschgen et al. 1984). NVP studies (Esler et al., unpubl. ms.) demonstrated that recapture probabilities of radio-marked harlequin ducks were not lower than unradioed individuals. Surgeries will be conducted by certified veterinarians experienced in avian implant surgeries, following procedures outlined in Alaska Biological Science Center, USGS Biological Resources Division standard protocol. Transmitters will weigh approximately 18g, which is $\leq 3\%$ of the body mass of the smallest wintering female harlequin ducks captured during NVP studies. Transmitters will be equipped with mortality sensors; the pulse rate will change from 45 to 90 beats per minute when a mortality is indicated. Mortality status will be confirmed by either carcass recovery or detection of signals from upland habitats, which are not used by harlequin ducks during nonbreeding periods.

We will conduct radio telemetry flights at approximately weekly intervals from the capture and marking period through the end of March. Survival data entry and analysis will follow procedures outlined in Pollock et al. (1989a, 1989b), as modified by Bunck et al. (1995). In brief, we will use a Kaplan-Meier staggered entry design to estimate cumulative survival probabilities. Log rank and Z-tests will be used to compare survival functions and point estimates, respectively, between years and areas (Pollock et al. 1989a). We also will analyze survival rates using data-based models (PROGRAM MARK) that allow individual covariates such as body mass and CYP1A levels to be included in the analysis.

CYP1A induction will be measured by EROD activity. Small liver biopsies (approximately 0.1 g) will be surgically removed and immediately frozen in a liquid nitrogen shipper. EROD

activity analyses will be conducted in a contracted lab following standard procedures. Plumage swabs (Duffy et al. 1999) will be used to assess presence of external oil.

For field studies, work in FY00 includes ordering radios (and designing a transmitter that avoids problems with extrusion [Mulcahy et al. 1999]), building winter traps, and other preparations (i.e., researching boat and air charter options, etc.). Field work will begin in early FY01 (November 2000).

Captive Bird Studies

Captive bird studies will examine metabolic, behavioral, and biomarker responses to known oil-dosing regimes. This work is designed to experimentally test effects of oil exposure on parameters that are hypothesized to influence dynamics of wild harlequin duck populations; these effects are impossible to assess under field conditions.

Harlequin ducks to be used in captive studies will be captured during wing molt from unoiled parts of PWS. During molt, harlequin ducks congregate and are susceptible to capture by herding flocks of flightless birds into pens (Clarkson and Goudie 1994). Birds will be banded with USFWS bands and with individually coded plastic tarsus bands. Tarsus bands will be oriented to be read from bottom to top as the bird is standing. Sex will be identified based on plumage characteristics and age class determined by bursal probing (Mather and Esler 1999). Body mass of all birds at capture will be measured.

Following capture, birds will be flown to the Alaska Sea Life Center in Seward. We intend to use approximately 20 birds each year for 2 years (winters 2000-01 and 2001-02). Captured individuals will undergo quarantine and adjustment periods prior to any experimental manipulation or dosing. Captive birds will be housed in outdoor pens to expose them to natural climatic and photoperiod conditions. Dosing will be designed to simulate long-term, intermittent exposure, which is likely similar to exposure experienced by wild birds. Numbers of dosing levels, amounts of doses, and frequency of dosing will be determined as part of literature review efforts proposed for FY00. Dosing will continue through the critical mid-winter period and behavioral and metabolic measures will be taken throughout the winter. Because CYP1A sampling requires a liver biopsy, we will get only 1 measure of induction, taken in late winter. Following a 2-week post-surgery recovery period (without any dosing), captive birds will be released in the area of their original capture.

Behavior of captive birds will be quantified using time-activity observations throughout winter for all dosing levels. Behavioral categories will follow those used in studies of wild harlequin ducks (Goudie and Ankney 1986, Fischer 1998), e.g., feeding, resting, swimming, courtship, etc. Time-activity budgets will be contrasted among dosing groups.

Metabolic consequences of oil exposure will be quantified using two approaches: doubly-labeled water to estimate daily energy expenditure (DEE) and oxygen consumption to estimate basal metabolic rate (BMR). This approach will allow different views into the metabolic effects of exposure. DEE is a measure of existence costs over longer (1-3 day) time periods. DEE

incorporates all of the metabolic costs during this time; elevated DEE in exposed birds would be consistent with a hypothesis of oil exposure increasing existence costs with potential survival implications. Similar DEE among treatments but different activity levels (see above) also would have implications for survival under natural conditions. BMR estimates metabolism without costs of thermoregulation, digestion, and activity; these data will assess whether background metabolic costs are higher in dosed than undosed birds. Body mass of all individuals also will be measured at all handling events; these data will be interpreted in light of metabolic and behavioral measurements.

DEE estimation using doubly-labeled water requires injection of water with both the oxygen and water isotopically-labeled. As the hydrogen is lost only through water and oxygen through both water loss and carbon dioxide production, the difference in turnover rates between marked hydrogen and oxygen can be used to estimate metabolism. BMR will be measured using a flow-through respirometer to measure oxygen consumption. A metabolic chamber for harlequin ducks will be built during FY00 preparations; an oxygen analyzer is on site at the Alaska Sea Life Center. BMR of all birds will be measured throughout the winter, including prior to any dosing to establish background rates.

CYP1A induction of all captive birds will be measured at the end of the experiment by EROD activity, described above. EROD activity will be compared among all treatments.

FY00 effort will include research to determine appropriate dosing regime, preparation of facilities at the Sea Life Center to house birds and conduct experiments, construction of an appropriate metabolic chamber for oxygen consumption measurements, field work to catch birds to establish the first winter's captive flock, and refinement of the experimental design and protocol. Experimental work will commence in early FY01 (fall 2000).

C. Cooperating Agencies, Contracts, and Other Agency Assistance

USGS-BRD personnel will be responsible for directing and conducting sea otter and harlequin duck studies.

Contract with Coastal Resources (Dr. Tom Dean) for sea otter invertebrate prey monitoring component.

Contract with Dr. Paul Snyder, Purdue University, for CYP1A assays of sea otter blood samples.

SCHEDULE

A. Measurable Project Tasks for FY00

Sea Otters

November:	Resighting of tagged & non-tagged sea otters in oiled and unoiled study areas, to enumerate tagged animals remaining from 1996-98 capture operations.
April:	Resighting of tagged & non-tagged sea otters in oiled and unoiled study areas, to enumerate tagged animals remaining from 1996-98 capture operations.
June-July:	Capture and tagging of sea otters in oiled and unoiled areas; collection of blood samples for CYP1A measurement. Aerial surveys of sea otters. Sampling of intertidal green sea urchins.
September:	Resighting of tagged & non-tagged sea otters in oiled and unoiled study areas.

Harlequin Ducks

April - August:	Prepare for field studies (e.g., order radios, contact boat charter operators, build winter trap, contact biosample contractors, etc.).
	Prepare for captive bird studies (coordinate with Alaska Sea Life Center personnel, contact aviculturists, build metabolic chamber, maintain molt trap, research appropriate dosing regime, order captive bird maintenance materials, arrange boat and air charters, etc.).
August - Sept.:	Capture birds during wing molt for creation of captive flock.
	Establish captive flock and initiate adjustment period.

B. Project Milestones and Endpoints

Sea Otters

FY00 (and out years):

November:	Visual count of tagged & non-tagged sea otters.
December-March:	Coordinate and plan aerial surveys, community involvement, prepare equipment.
April:	Resighting of tagged and non-tagged sea otters.

June-August:	Conduct aerial sea otter surveys and sea urchin surveys; capture sea otters for CYP1A and tagging.
September-Nov:	Data analysis and report preparation. Coordinate with local communities.

Harlequin Ducks

Field studies are scheduled to occur from November through March, winters 2000-01, 2001-02, and 2002-03. Captive bird experimental work is scheduled for winters 2000-01 and 2001-02. Reporting schedule is described below.

This is a projected five-year research and monitoring program designed to assess the recovery of an injured species. Each project objective will be assessed annually for oiled and unoiled areas then compared with each other and with data collected in subsequent years. Year to year trends will first be compared in 2000 and then each year after. At the end of each year results will be compared with the restoration goals to assess whether recovery has occurred.

C. Completion Date

All project objectives will be met by FY03.

PUBLICATIONS AND REPORTS

Annual reports will be presented to the Chief Scientist by April 15. An annual report of FY00 activities will be submitted to the Restoration Office before 15 April 2001. A final report will be prepared at the end of the proposed work unless continued monitoring is warranted or when recovery objectives are met. Special reports (publications) will be prepared during the course of the study if warranted. Publications will be prepared for peer-review journals when sufficient data have been collected.

PROFESSIONAL CONFERENCES

None in FY00.

NORMAL AGENCY MANAGEMENT

The work proposed here is not part of normal agency management and is related specifically to research addressing oil spill restoration concerns. No similar work has been conducted, is currently being conducted, or is planned using agency funds.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

As described in the Introduction, this research relies on incorporation of data from other Trustee sponsored research, including projects /025 and /427. Equipment and commodities purchased under /025 will be used to conduct the proposed research and data collection and analysis will follow previously established protocols and standards.

EXPLANATION OF CHANGES IN CONTINUED PROJECTS

We initially projected a budget of $63,000 for Project 00423 in FY00, to conduct 2 components of sea otter research/monitoring (2nd year of a 5 year project): aerial surveys of sea otter distribution and abundance, and surveys of intertidal green sea urchins. Based on examination of three years of NVP data (96-98) on sea otters and harlequin ducks, we have expanded the scope of work proposed in 00423. The revised proposal includes 2 more sea otter components: monitoring of CYP1A as a bioindicator of oil exposure, and evaluation of survival and mortality with a mark-resighting program. Two harlequin duck research and monitoring components have also been incorporated into the revised proposal: a captive bird study and a field study, both to examine links between oil exposure and survival rates.

A breakdown of the budget by the various project components, for FY2000, FY2001, and FY2002, is presented below (figures shown in thousands of dollars; general administration costs not included):

YEAR	SEA OTTERS		HARLEQUIN DUCKS	
	Aerial Surveys & Sea Urchin Sampling[a]	Field Studies[b]	Captive Birds[c]	Field Studies[d]
FY00	59.3	124.2	52.5	24.8
FY01	44.4	117.8	86.5	112.3
FY02	60.4	71.6	68.6	112.3
FY03	45.1	30.7	24.0	101.0
Average per year	52.3	86.1	57.9	87.6

[a] These components were funded in FY99 as project 99423, 1st year of a 5 year project.
Newly proposed components:
[b] Monitoring of CYP1A and assessment of mortality/emigration by mark-resighting program.
[c] Studies on captive birds at the Seward Sea Life Center.
[d] Studies on wild birds to monitor CYP1A and survival.

PROPOSED PRINCIPAL INVESTIGATORS

James Bodkin
Alaska Biological Science Center
USGS-Biological Resources Division
1011 E. Tudor Rd.
Anchorage, Alaska 99503
PHONE: (907) 786-3550
FAX: (907) 786-3636
james_bodkin@usgs.gov

Dan Esler
Alaska Biological Science Center
USGS-Biological Resources Division
1011 E. Tudor Rd.
Anchorage, AK 99503
PHONE: (907) 786-3485
FAX: (907) 786-3636
daniel_esler@usgs.gov

Tom Dean
Coastal Resources Associates, Inc.
1185 Park Center Drive, Suite A
Vista, CA 92083
PHONE: (760) 727-2004
FAX: (760) 727-2207
coastal_resources@compuserve.com

Brenda Ballachey
Alaska Biological Science Center
USGS-Biological Resources Division
1011 E. Tudor Rd.
Anchorage, Alaska 99503
PHONE: (907) 786-3512
FAX: (907) 786-3636
brenda_ballachey@usgs.gov

PRINCIPAL INVESTIGATOR QUALIFICATIONS

Jim Bodkin, Research Wildlife Biologist, and team leader for coastal ecosystem in Alaska for the Alaska Biological Science Center of USGS, Biological Resources Division. He has over 20 peer-reviewed scientific publications and directs an active coastal marine research program. He has studied and published on sea otter foraging ecology and community structuring since 1988

and has been principal investigator for sea otter survey methods development. He earned a M.S. from California State Polytechnic University in 1986.

Dan Esler is a Research Wildlife Biologist with the Alaska Biological Science Center, USGS Biological Resources Division. He has conducted waterfowl research in arctic and subarctic regions of Alaska and Russia for the past 10 years. Since 1995 he has served as project leader for harlequin duck studies as part of the EVOSTC-sponsored Nearshore Vertebrate Predator project. He earned a M.S. from Texas A & M University in 1988 and is currently enrolled as a doctoral candidate at Oregon State University. He has authored 17 peer-reviewed journal publications and numerous reports and presentations addressing research and issues in waterbird conservation.

Thomas A. Dean is President of the ecological consulting firm Coastal Resources Associates, Inc. (CRA) in Vista CA. Dr. Dean has over 20 years of experience in the study of nearshore ecosystems, and has authored over 25 publications, including several dealing with impacts of the *Exxon Valdez* oil spill on subtidal populations of plants and animals. He has extensive experience in long-term monitoring studies, and has played a major role in both intertidal and subtidal EVOS investigations since 1989. Dr. Dean is currently a co-principal investigator for the Nearshore Vertebrate Predator Project (NVP), and is examining the relationships between prey abundance and the recovery of sea otters, river otters, harlequin ducks, and pigeon guillemots.

Dr. Brenda Ballachey, B.S., M.S. 1980 Colorado State University, Ph.D. 1985 Oregon State University, is a Research Physiologist at the Alaska Biological Science Center of USGS, Biological Resources Division. She was Project Leader for sea otter NRDA studies from 1990 through 1996, and has been involved in all aspects of post-spill research on sea otters. She has authored or coauthored over 25 peer-reviewed publications, and is currently a co-principal investigator for the Nearshore Vertebrate Predator (NVP) project, examining effects of residual oil on health and recovery of sea otters and other NVP study species.

KEY COOPERATORS

Sea Otters

Daniel Monson
Alaska Biological Science Center
USGS-Biological Resources Division
1011 E. Tudor Rd.
Anchorage, AK 99503
PHONE: (907) 786-3449
FAX: (907) 786-3636
daniel_monson@usgs.gov

Paul Snyder, DVM, PhD
Purdue University
Department of Veterinary Pathobiology
West Lafayette, IN 47907-1243
PHONE: (765) 494-9676
FAX: (765) 494-9830
pws@vet.purdue.edu

Harlequin Ducks

Kim Trust
U. S. Fish and Wildlife Service
Ecological Services
605 W. 4th Avenue, Room G62
Anchorage, AK 99501
(907) 271-2783
kim_trust@mail.fws.gov

Daniel Mulcahy, DVM, PhD.
Alaska Biological Science Center
USGS-Biological Resources Division
1011 E. Tudor Rd.
Anchorage, AK 99503
(907) 786-3451
daniel_mulcahy@usgs.gov

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2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000						
Personnel	$19.3	$110.6						
Travel	$4.6	$10.1						
Contractual	$30.8	$113.7						
Commodities	$1.2	$21.1						
Equipment	$0.6	$4.9	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$56.5	$260.4			Estimated FY 2001	Estimated FY 2002		
General Administration	$3.5	$24.5						
Project Total	$60.0	$284.9			$392.6	$345.1		
Full-time Equivalents (FTE)		2.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

We initially projected a budget of $63,000 for Project 00423 in FY00, to conduct 2 components of sea otter research/monitoring (2nd year of a 5 year project). However, we have expanded the scope of work, and the increase in FY00 total budget over the previously projected budget is due to the addition of 2 more sea otter research and monitoring components and 2 harlequin duck research and monitoring components.

No costs are included for NEPA compliance, technical review session attendance, report writing, publications, professional conferences, or community involvement. $500.00 in travel is included for annual restoration workshop attendance.

FY00

Prepared: 14 April 99

Project Number: 00423
Project Title: Patterns and Processes of Population Change in Selected Nearshore Vertebrate Predators
Agency: DOI

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
SEA OTTER						
J. Bodkin	Research Wildlife Biologist	GS 13-2	1.5	7.2		10.8
B. Ballachey	Research Wildlife Biologist	GS 12-04	3.0	6.0		18.0
D. Monson	Research Wildlife Biologist	GS 9-02	7.0	4.2		29.4
Field Assistant	Biotechnician	GS 7	3.0	3.3		9.9
						0.0
HARLEQUIN DUCK						0.0
D. Esler	Research Wildlife Biologist	GS 12	4.0	6.0		24.0
K. Trust	Biologist	GS 11	1.0	5.3		5.3
Biotechnician	Biotechnician	GS 7	4.0	3.3		13.2
						0.0
						0.0
	Subtotal		23.5	35.3	0.0	
					Personnel Total	$110.6

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
SEA OTTER					
Anch/Cord/Anch	0.3	2	24	0.1	3.0
Annual Meeting	0.6	1	5	0.2	1.6
Boat transportation to Whitter	0.7	2	2	0.1	1.6
Field crew/gear to Whittier	0.1	3	6	0.1	0.9
					0.0
HARLEQUIN DUCK					0.0
Esler-Seward			25	0.1	2.5
Field crew/gear to Whittier	0.5	1			0.5
					0.0
					0.0
					0.0
				Travel Total	$10.1

FY00

Prepared: 14 April 99

Project Number: 00423
Project Title: Patterns and Processes of Population Change in Selected Nearshore Vertebrate Predators
Agency: DOI

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:		Proposed
Description		FY 2000
SEA OTTER		
Aircraft charter 80 hra @ 200/hr		16.0
4A Linkage Coastal Resources Associates		15.1
CYP1A Assays - Purdue Univ.	60 @ $125	7.5
Vessel charter, late winter	10 days @ $1200	12.0
Vessel charter, summer capture	20 days @ $1500	30.0
Vessel charter - supplement HD charter, late summer	9 days @ $300	2.7
Vessel charter, late fall	10 days @ $1200	12.0
Blood analyses--serology	60 @ $40	2.4
HARLEQUIN DUCK		
Vessel charter - late summer, capture	9 days @ 1.5	13.5
Air charter (transport birds to Seward)	10 hours @ $250	2.5
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$113.7

Commodities Costs:		Proposed
Description		FY 2000
SEA OTTER		
Veterinary and biosampling supplies		0.9
Miscellaneous field/office supplies		1.5
Fuel		3.0
HARLEQUIN DUCK		
Kayak rental	6 @ $150	0.9
Molt trap maintenance		0.5
Captive flock maintenance	1 month @ $450	0.5
Metabolic chamber materials		1.0
Winter trap materials		1.5
Radio transmitters	50 @ $225	11.3
	Commodities Total	$21.1

FY00

Prepared: 14 April 99

Project Number: 00423
Project Title: Patterns and Processes of Population Change in Selected Nearshore Vertebrate Predators
Agency: DOI

FORM 3B
Contractual & Commodities DETAIL

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

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2000
SEA OTTER			
Questar scope	1	2.2	2.2
Tripod	1	0.3	0.3
Equipment maintenance and repair			2.4
			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**		$4.9

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

FY00

Prepared: 14 April 99

Project Number: 00423
Project Title: Patterns and Processes of Population Change in Selected Nearshore Vertebrate Predators Sea Otters
Agency: DOI

FORM 3B
Equipment
DETAIL

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$7.2
Travel		$0.9
Contractual		$0.0
Commodities		$0.5
Equipment		$0.0
Subtotal	$0.0	$8.6
Indirect		$6.5
Project Total	$0.0	$15.1
Full-time Equivalents (FTE)		0.1
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 2001	Estimated FY 2002
$0.0	$16.0

Dollar amounts are shown in thousands of dollars.

Comments:

Indirect costs calculated as follows:

Indirect costs = Overhead + General and Administrative costs + Fee

Overhead = 59.5% of personnel costs

G&A = 12.85% of personnel + overhead + other direct (excluding contractual)

Fee = 4% of Total Direct + Indirect (excluding contractual)

No overhead or fees are charged on contractual costs

FY00

Prepared: 14 April 99

Project Number: 00423
Project Title: Patterns and Processes of Population Change in Selected Nearshore Vertebrate Predators
Name: Thomas A. Dean - Coastal Resources Associates, Inc.

FORM 4A
Non-Trustee
SUMMARY

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2000
	T. Dean	Biologist	0.7	8.1		5.7
	D. Jung	Biologist	0.4	3.7		1.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	1.1	11.8	0.0	
					Personnel Total	$7.2

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2000
	San Diego/Anch/SanDiego	0.6	1	3	0.1	0.9
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$0.9

FY00

Prepared: 14 April 99

Project Number: 00423
Project Title: Patterns and Processes of Population Change in Selected Nearshore Vertebrate Predators
Name: Thomas A. Dean - Coastal Resources Associates, Inc.

FORM 4B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed FY 2000
Description	
Contractual Total	$0.0

Commodities Costs:	Proposed FY 2000
Description	
Miscellaneous field supplies	0.5
Commodities Total	$0.5

FY00

Prepared: 14 April 99

Project Number: 00423
Project Title: Patterns and Processes of Population Change in Selected Nearshore Vertebrate Predators
Name: Thomas A. Dean - Coastal Resources Associates, Inc.

FORM 4B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2000
Description			
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number of Units	
Description		

FY00

Prepared: 14 April 99

Project Number: 00423
Project Title: Patterns and Processes of Population Change in Selected Nearshore Vertebrate Predators
Name: Thomas A. Dean - Coastal Resources Associates, Inc.

FORM 4B
Equipment
DETAIL

Effects of Forage Fish School Density and Species Composition on Foraging Patterns of Sea Birds: A Synthesis Product

Project Number:	00433
Restoration Category:	Research
Proposer:	University of Alaska Fairbanks
Lead Trustee Agency:	ADFG
Cooperating Agencies:	UAF
Alaska SeaLife Center:	
Duration:	1st year of 2 years
Cost FY 00:	$55,755 + ADFG Overhead $3,903 = $59,658
Cost FY 01:	$24,600
Cost FY 02:	$ 0
Geographic Area:	Prince William Sound (PWS)
Injured Resource/Service:	Pacific herring, Sea birds (Marbled murrelet, Pigeon guillemot, Black-legged kittiwake)

ABSTRACT

The main goal for this project is to improve our understanding of finer scale foraging processes. Using existing digital imagery and underwater photography, we will examine how school spacing, density, and species composition of forage fish in shallow regions and surface waters affect the foraging pattern of sea birds (mainly kittiwakes). We intend to use multivariate statistics to detect significant differences. We will also determine if there is a species preference and estimate thresholds of fish abundance for commencement of observed foraging. Area specific trends can be compared to bird diet data for coherence in observations by other APEX researchers.

INTRODUCTION

This project uses existing data to address core hypotheses of the Alaska Predator Ecosystem Experiment (APEX) project concerning forage fish characteristics and interactions among seabirds (see Hypotheses 5, and 6, Duffy 1998). The dynamics and limiting factors between forage fish assemblage characteristics and foraging success of sea birds are poorly understood. The findings of this study are therefore important in gaining a better understanding of those dynamics. The specific hypotheses that will be tested within this project are:

1. Numbers and patterns of sea birds foraging on surface fish school assemblages are dependent on fish species, age of the fish, school size, and school density

2. There is a region-specific threshold of fish school size and number below which foraging by seabirds is unlikely.

A primary objective of this project is to interpret, on the order of a few hundred meters, finer scale processes that affect sea bird foraging success. We will focus on three species of forage fish including Pacific herring (*Clupea pallasi*), sand lance (*Ammodytes hexapterus*), and capelin (*Mallotus villosus*). Our findings will provide information on an unknown aspect of feeding behavior and will be useful in the interpretation of sea bird diets and reproductive success (particularly in the context of other APEX studies).

We have three types of data that will be used in this investigation. We have a 5-year database including distribution and abundance of surface schooling forage fish and sea birds (example of output in Figure 1). We will have collected over 400 digital aerial images of forage fish schools and the associated sea birds (1998 coverage is in Figure 2; examples in Figure 3). Finally, we will have a collection of over 200 underwater images (associated with the aerial sightings and images) of forage fish schools. The investigator in this project has used digital images in the past to estimate parameters for modeling aerial survey data (Brown and Borstad, 1998). This takes the utility of those images one step further. Therefore, this project is cost-effective since it entails only the processing of existing data and images.

There is evidence from past analyses that seabirds exhibit a prey species preference. Certainly the energetic characteristics, and therefore diet quality, of different species and ages of forage fish vary (Duffy, 1998). This investigator found that there was a significant difference in the numbers of herring versus sand lance schools associated with birds. In 1996 and 1997, 35.7% and 43.6% of juvenile herring schools, respectively, had foraging birds associated with them. This compares with 18.3% (1996) and 11.1% (1997) of sand lance schools. The frequency distribution of school sizes associated with the sea birds was not different between the two fish Figure 1. Locations of foraging kittiwakes, sand lance and herring schools in a blown-up region in central Prince William

Sound (Knight Island group and Smith Island).

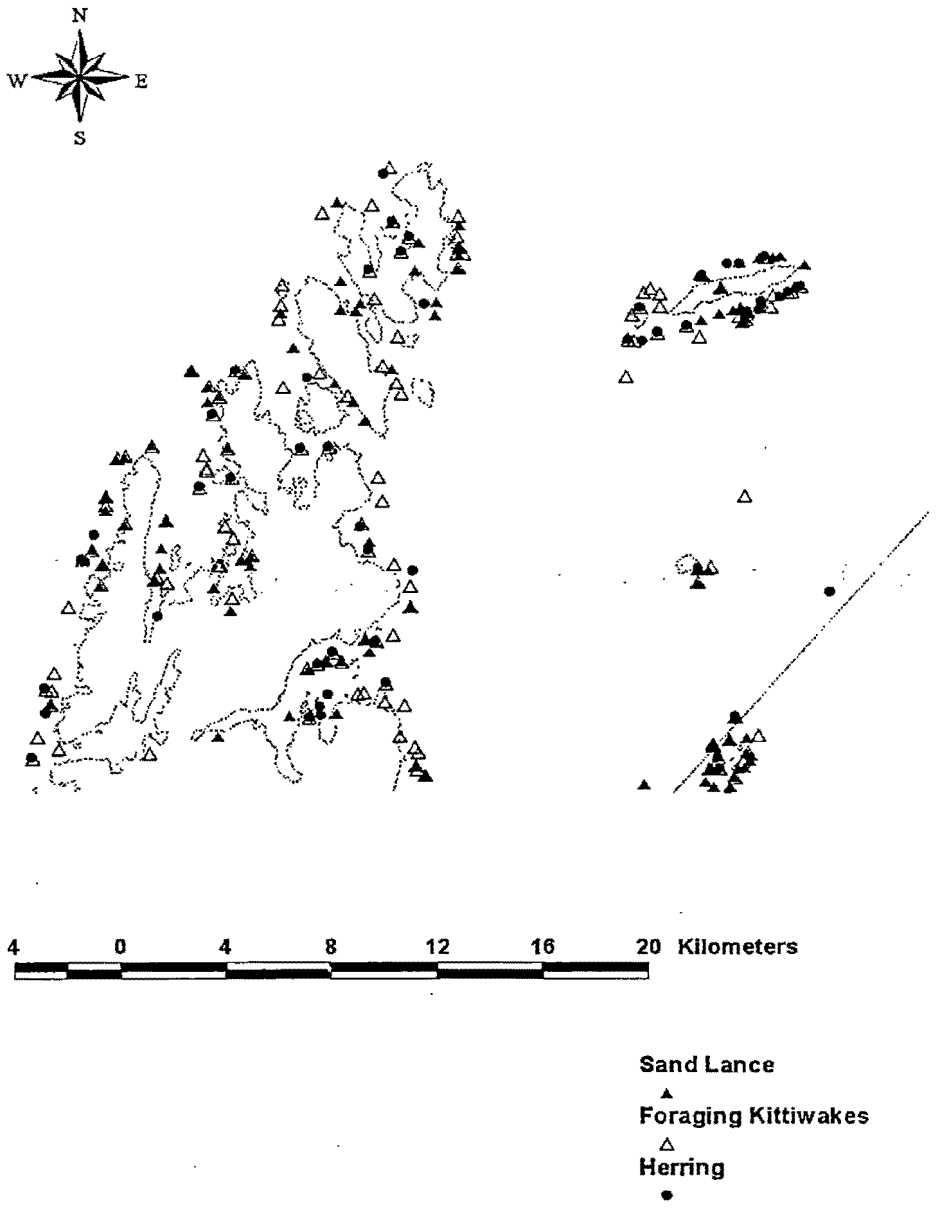


Figure 2. Locations of digital images collected in 1998 in Prince William Sound.

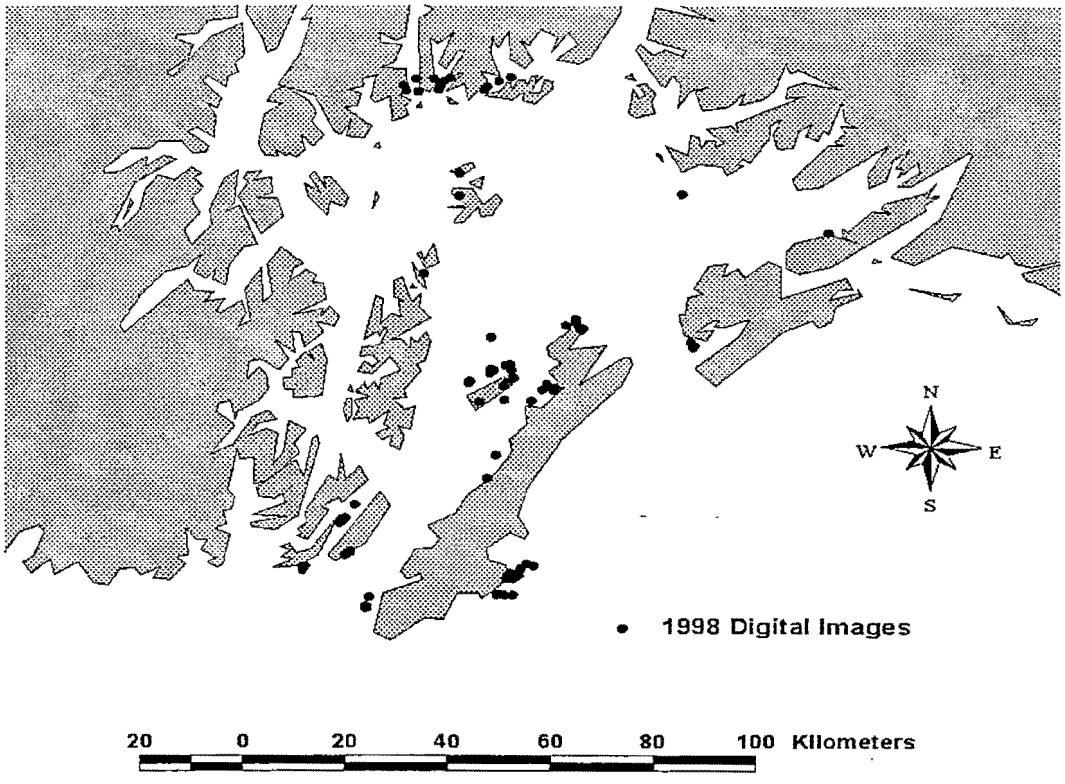
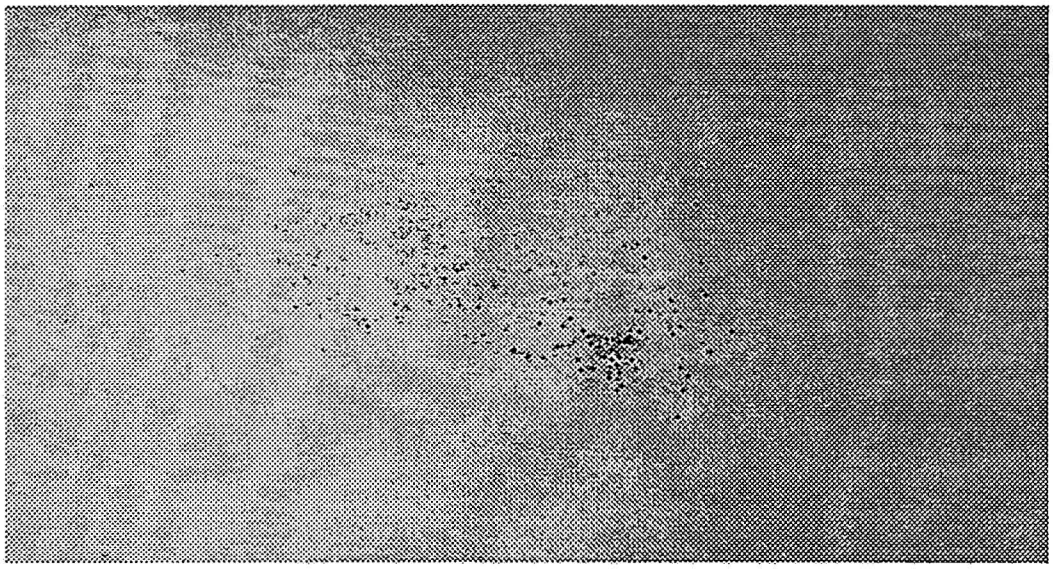
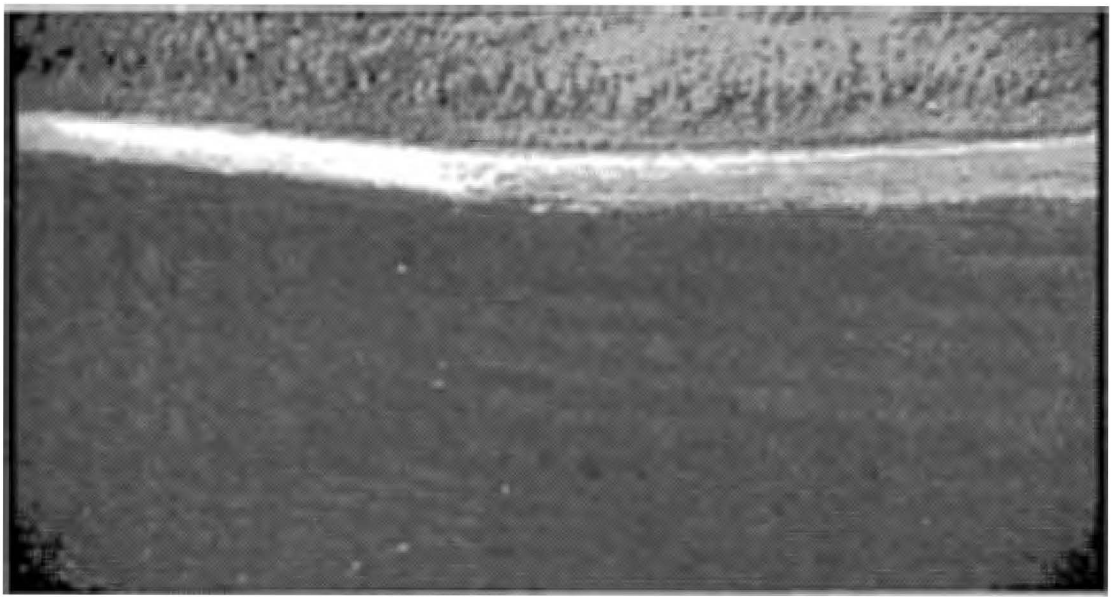


Figure 3. Examples of digital images from 1998.



a. Enhanced photo of resting bird pattern.



b. Age-0 sand lance, kittiwakes and alcids.

species. However, total numbers of schools within an area (or shoal size), biomass, and density was different for each of the two species and could have been a confounding factor. We intend to address that question within the context of this study.

NEED FOR THE PROJECT

A. Statement of Problem

Factors limiting the recovery of sea birds include insufficient prey or poor prey quality. Several seabird species were listed as injured by the spill. However, little is known of the factors influencing foraging by seabirds or whether characteristics of forage fish assemblages (e.g. school size and density) may be important. This project will assess forage fish assemblage characteristics that may affect the dynamics of foraging by sea birds to determine whether changes in assemblage characteristics can serve to limit seabird recovery. This project will serve as a synthesis for ongoing APEX investigations. It includes the study of Pacific herring (*Clupea pallasi*) which were injured but now recovering from the spill. Our findings will increase our understanding of the partitioning of juvenile herring nurseries and population structure.

B. Rationale/Link to Restoration

The research completed under this project using existing data from both the SEA and APEX projects will help us refine our understanding of foraging dynamics between sea birds and forage. This project will address core hypotheses 5 and 6 of the APEX project (Duffy 1998).

C. Location

The data for this project was collected mainly in July and August from 1996–1998 in Prince William Sound. We will also use new data collected in the summer of 1999 in the same region.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Although we have no direct involvement of the public, the images produced by this project can be used for public education purposes. As part of our deliverables, we will provide a GIS CD with the geocoded images for public viewing and use.

PROJECT DESIGN

A. Objectives

The primary objective of this project is to address the two key hypotheses:

1. Numbers and patterns of sea birds foraging on surface fish school assemblages are dependent on fish species, age of the fish, school size, and school density.

2. There is a region-specific threshold of fish school size and number below which foraging by seabirds is unlikely.

We intend to provide critical information concerning the relationship of forage fish assemblages to seabird foraging. This information will be placed in the context of other APEX investigations as well as in the context of limitations of seabird recovery from oil spill. The research tasks designed to test these hypotheses are:

1. Group the images by region, species, and by shoal size (number of schools in each image quadrat) and assign continuous or categorical variables (these are the predictor variables).

2. For each image processed, determine the total number of kittiwakes and the nearest neighbor statistics of the birds (response variables).

3. Use multivariate statistics to determine statistical correlations and relationships between the predictor and response variables. Use parametric and non-parametric tests for level of significance.

4. Determine if thresholding is occurring (no response values below defined levels of the predictor variables) and define it. Develop a probability associated with the threshold.

B. Methods

Aerial surveys were conducted in PWS, a small adjacent portion of the Gulf of Alaska, and the Outer Kenai from 1995 to 1997 (Brown and Norcorss, 1997). Methodology for the surveys was developed in those years. In 1998 repeat surveys were conducted over a more restricted temporal and spatial scale. In addition, the digital video camera was added to the survey plane.

Each image is assigned a name or number, is associated to a particular latitude and longitude, and is linked to aerial and validation data that provides fish species and age. It is also given a region code. The validation data comes from net catches linked via time and space codes to the images or from underwater video images that were taken synoptic with the aerial images.

Each image can be scaled using altitude since the focal point and settings on the camera were static. The image is imported into ArcView Geographic Information System (GIS) software and gridded according to the predetermined scale (dimensions of the image in meters; see Verbyla and Chang, 1997). Bird locations and school perimeters are digitized on the image. The statistics for school area and bird counts are then automatically determined within the software. Nearest neighbor statistics can also be calculated. All the output can be dumped to a spreadsheet or directly to S-plus statistical package (Spector 1994).

The data linked to each image is then sorted by region and other characteristics to determine if clumping of variables is occurring. We expect, due to the clumping of images in particular locations, that we may have to deal with spatial autocorrelation. If we find this to be a problem, we will group images and analyze image groups instead (i.e., analyze means of image groups) which will affect the overall sample size and may affect our choice of test to use.

We will use a multivariate approach for the analysis of the data. Applicable multivariate methods include canonical correlation analysis and multi-dimensional scaling. Expected statistical tests for significance of the results includes Bartlett's and the Mantel test (Manly 1986). The choice for tests will depend on the realized sample size, the difficulty in interpretation of the correlation coefficients, and the level of significance realized.

Significant results will be summarized in a publication. We will also deliver the data set for public use in the form of a CD containing the GIS database, the images, and ancillary data.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The Institute of Marine Science at UAF is the main agency included in this proposal. We will contract with Top Cover Inc., an Alaskan company, for delivery and processing of the digital images.

SCHEDULE

A. Measurable Project Tasks for FY 00 (October 1, 1999 – September 30, 2000)

In FY 00, we will address the objectives with the following tasks:

December 31, 1999;	Acquire and organize all digital images and associated data needed to create the variables.
February 28, 2000	Scale images and digitize parameters from each image.
March 1, 2000:	Participate in annual EVOS review.
March 15, 2000:	Complete nearest neighbor statistics for birds and schools.
May 15, 2000:	Complete multivariate analysis.
June 15, 2000:	Complete and submit the publication.

In FY 01, we address the objectives with the following tasks:

December 15, 2000:	Revise and finalize publication.
April 15, 2001:	Submit final report and reprint.

B. Project Milestones and Endpoints

FY 00

May 15, 2000:	Analysis complete.
June 15, 2000:	Publication submitted.

FY 01

December 15, 2000:	Publication finalized.
April 15, 2001:	Submit final report and CD.

C. Completion Date

December 15, 2001 for publication
April 15, 2001 for final report.

PUBLICATIONS AND REPORTS

An annual report will be prepared for the April 2000 deadline, but the final report will be in the form of a publication reprint.

The draft title for the FY 01 publication is: Effects of forage fish school density and species composition on foraging patterns of sea birds. By Blanchard A., E. Brown, T. Veenstra, and S. Moreland. This will be submitted to: Marine Ecological - Progress Series; or, Fisheries Oceanography.

PROFESSIONAL CONFERENCES

During FY 00, we will attend the EVOS symposium and review. At this time, we do not have plans to present the results at a scientific meeting.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project represents a synthesis of current information resulting from EVOS restoration research. Data from the SEA and APEX project will incorporated in this analysis.

PROPOSED PRINCIPAL INVESTIGATORS

Evelyn D. Brown
University of Alaska Fairbanks
Institute of Marine Science
School of Fisheries and Ocean Sciences
Fairbanks, AK 99775-7220
Phone: 907-474-5801
Fax: 907-474-1943
E-mail: ebrown@ims.uaf.edu

Brenda L. Norcross
University of Alaska Fairbanks
Institute of Marine Science
School of Fisheries and Ocean Sciences
Fairbanks, AK 99775-7220
Phone: 907-474-7990
Fax: 907-474-1943
E-mail: norcross@ims.uaf.edu

PRINCIPAL INVESTIGATORS

Evelyn D. Brown (formerly Biggs)

Responsible for meeting project objectives and tasks; formulation of publication.

Education:

B.S. Zoology and Chemistry, University of Utah, Salt Lake City, 1977

M.S. Fisheries Biology and Aquacultural Engineering, Oregon State University, Corvallis, OR, 1980

Current PhD candidate in Fisheries at University of Alaska, Fairbanks

Experience:

Research Associate, University of Alaska, Fairbanks, 1995 to the present.

Herring and Fisheries Research Biologist, Alaska Department of Fish and Game, Cordova, Alaska from 1985 to 1995.

Principal Investigator, Injury to Prince William Sound Herring from the *Exxon Valdez* Oil Spill, NRDA FS 11, 1989–1992.

Fisheries Biologist, Florida Department of Natural Resources, St. Petersberg, Florida, 1987–1988; hydroacoustics.

Fisheries Management Biologist, Metlakatla Indian Community, Annette Island, Alaska, 1980–1982.

Field Experience:

Aerial surveys; P.I. and primary surveyor, single engine aircraft; 1988–present.

U.W. Dive Surveys; P.I. and dive officer for ADFG dive program; 1988–1995.

Shipboard surveys; small vessels (30–60 ft); P.I. on 2, participated in over 12; last decade.

Large shipboard surveys; over 100 ft; participant; 1983 GOA and 1998 SE Alaska.

Skiff work; participated annually in solo and team operations of marine research from skiffs from 1979 to the present.

Familiarity with a variety of marine electronics from acoustics, side-scan sonars, GPS, and computerized navigation to a Compact Airborne Spectrographic Imager (CASI).

Selected Publications:

Brown, E.D., G.A. Borstad, K.D.E. Stokesbury, and B.L. Norcross. Accepted, manuscript in prep. Calibrating and improving the utility of aerial surveys via the use of CASI, videography, and acoustics in American Fisheries Society Symposium 00:00 (1998 in Hartford, Connecticut).

Brown, E. D., G.A. Borstad, and B.L. Norcross. In prep. Assessment of forage fish distribution and abundance using aerial surveys: survey design and methodology. (To be submitted to Ecological Applications).

Brown, E.D. , S. Vaughan, and B.L. Norcross. In press. Annual and seasonal spatial variability of herring, other forage fish, and seabirds in relation to oceanographic regimes in Prince William

Sound, Alaska *in* Ecosystem Considerations in Fisheries Management, AFS/Lowell-Wakefield Symposium 00:00 (1998 in Anchorage, Alaska).
Stokesbury, K. D. E., J. Kirsch, E. D. Brown, G. L. Thomas, B. L. Norcross. Accepted. Seasonal variability in Pacific herring (*Clupea pallasi*) and walleye pollock (*Theragra chalcogramma*) spatial distributions in Prince William Sound, Alaska. Fisheries Research 00:00.
Brown, E.D., T.T. Baker, J.E. Hose, R.M. Kocan, G.D. Marty, M.D. McGurk, B.L. Norcross, and J. Short. 1996. Injury to the early life history stages of Pacific herring in Prince William Sound after the *Exxon Valdez* oil spill. Am. Fish. Soc. Symp. 18. pp. 448–462.
Brown, E.D., B.L Norcross, and J.W. Short. 1996. An introduction to studies on the effects of the *Exxon Valdez* oil spill on early life history stages of Pacific herring, Clupea pallasi, in Prince William Sound, Alaska. *Can J. Fish. Aq. Sci.* 53: 2337–2342
Brown, E.D. and E. M. Debeves. In press. Effects of the *Exxon Valdez* oil spill on in situ survival of Pacific herring (*Clupea pallasi*) eggs. *Can J. Fish. Aq. Sci.*

Brenda L. Norcross

Advisory capacity on project.

Education:

A.B., Biology, MacMurray College, Jacksonville, Illinois, 1971.
M.S., Biology, St. Louis University, St. Louis, Missouri, 1976.
Ph.D., Marine Science, Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, Gloucester Point, Virginia, 1983.

Experience:

Associate Professor, Institute of Marine Science, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 1996–present.
Assistant Professor, Institute of Marine Science, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 1989–1996.
Assistant Professor, Division of Biological Oceanography and Fisheries Science, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia, 1984–1988.

Field Experience:

One fisheries vessel, Principal Investigator, Pelagic fish, zooplankton, hydroacoustics, oceanography, underwater camera (Prince William Sound, 7 days), 1998.
One – five fisheries vessels, Principal Investigator, Pelagic fish, zooplankton, hydroacoustics, oceanography, underwater camera, aerial surveys (Prince William Sound, 34 days), 1997.
Five fisheries vessels, Principal Investigator, Pelagic fish, zooplankton, hydroacoustics, oceanography, aerial surveys (Prince William Sound, 60 days), 1996.
Six fisheries vessels, Principal Investigator, Pelagic fish, hydroacoustics, oceanography, aerial surveys (Prince William Sound, 22 days), 1995.

Selected Publications:

Norcross, B.L. and F.J. Mueter. 1999. The use of an ROV in the study of juvenile flatfishes. *Fish. Res.* In press.

Foy, R.J. and B.L. Norcross. 1999. Spatial and temporal differences in the diet of juvenile Pacific herring (*Clupea pallasi*) in Prince William Sound, Alaska. *Can. J. Zoolog.* In press.

Norcross, B.L., J.E. Hose, M. Frandsen and E. Brown. 1996. Distribution, abundance, morphological condition and cytogenetic abnormalities of larval herring in Prince William Sound, Alaska, following the *Exxon Valdez* oil spill. *Can. J. Fish. Aquat. Sci.* 53:2376–2387.

Brown, E.D., B.L. Norcross and J.W. Short. 1996. Conditions affecting the distribution of oil from the *Exxon Valdez* spill and exposure of Pacific herring, *Clupea pallasi*, in Prince William Sound, Alaska. *Can. J. Fish. Aquat. Sci.* 53:2337–2342.

Norcross, B.L. and M. Frandsen. 1996. Distribution and abundance of larval fishes in Prince William Sound, Alaska during 1989 after the *Exxon Valdez* oil spill. *In* S.D. Rice, R.B. Spies, D.A. Wolfe and B.A. Wright (eds.). *Exxon Valdez* Oil Spill Symposium Proceedings. *Am. Fish. Soc. Symp.* 18:463–486.

OTHER KEY PERSONNEL

Arny L. Blanchard

Conduct the multivariate analysis of foraging dynamics; formulation of publication

Education:
B.S. Biological Sciences, University of Alaska Fairbanks. 1989.
M.S. Statistics, University of Alaska Fairbanks. Expected graduation date May 1999.

Positions Held:
Research Associate, University of Alaska Fairbanks, Nov. 1996 to present.
Laboratory Technician, University of Alaska Fairbanks, 1990 to present.
Laboratory Assistant, University of Alaska Fairbanks, 1989 to 1990.
Student Assistant, University of Alaska Fairbanks, 1986 to 1989.

Research Experience:
Provide statistical consulting services to principal investigators (1995 to present). Projects included assessment of habitat utilization by juvenile flatfish, trends in heavy metal concentrations from the Chukchi Sea, and assessment of disturbance in benthic communities due to dredging, gold mining, and disposal of treated ballast waters from oil tankers.

Coordinate environmental monitoring projects throughout Alaska to assess stress on benthic communities (1990 to present). Research experience includes investigations of intertidal mussels and limpets, intertidal community recruitment and succession, taxonomy of Alaskan marine invertebrates, and assessment of the effects of physical disturbance (dredging and gold mining), long-term waste disposal, and the *Exxon Valdez* oil spill.

Selected Published Papers:

Blanchard, A. and H. M. Feder. 1997. Reproductive timing and nutritional storage cycles of *Mytilus trossulus* Gould, 1850, in Port Valdez, Alaska, site of a marine oil terminal. Veliger, 40:121–130.

Blanchard, A. and H. M. Feder. In Press. Shell Growth of *Mytilus trossulus* Gould, 1850, in Port Valdez, Alaska. Veliger.

S.C. Jewett, T. A. Dean, R. 0. Smith, and A. Blanchard. In Press. The *Exxon Valdez* oil spill: impacts and recovery in the soft-bottom benthic community in and adjacent to eelgrass beds. Marine Ecology Progress Series.

Feder, H. M. and A. Blanchard. 1998. The deep benthos of Prince William Sound, Alaska, sixteen months after the *Exxon Valdez* Oil Spill. Marine Pollution Bulletin, 36:118–130.

Norcross, B. L., A. Blanchard, and B. A. Holladay. 1998. Comparison of models for defining nearshore flatfish nursery areas in Alaskan waters. Fisheries Oceanography. 8:50–67.

LITERATURE CITED

Brown, E.D. and G.A. Borstand. 1998. Progress report on aerial survey development, Appendix III, Chapter 11 *In:* Cooney, R.T. 1997. Sound Ecosystem Assessment (SEA) – an integrated science plan for the restoration of injured species in Prince William Sound. FY 96 Annual Report for the *Exxon Valdez* Trustee Council, Anchorage, Alaska. Pages 61–78.

Brown, E.D. and B.L. Norcross. 1997. Assessment of forage fish distribution and abundance using aerial surveys: survey design and methodology, Appendix I, Chapter 11 *In*: Cooney, R.T. 1997. Sound Ecosystem Assessment (SEA) – an integrated science plan for the restoration of injured species in Prince William Sound. FY 96 Annual Report for the *Exxon Valdez* Trustee Council, Anchorage, Alaska. Pages 25–53.

Duffy, D.C. 1998. APEX project: Alaska Predator Ecosystem Experiment in Prince William Sound and the Gulf of Alaska. Restoration project 97163A–Q. FY 97 Annual Report for the *Exxon Valdez* Trustee Council, Anchorage, Alaska. 420 pp.

Manly, B.F.J. 1986. Multivariate Statistical Methods A Primer. Chapman and Hall, London, England 213 pp.

Spector, P. 1994. An introduction to S and S-Plus. Duxbury Press, Belmont, CA. 286 pp.

Verbyla, D.L. and K. Chang. 1997. Processing digital images in GIS. Onword Press, Santa Fe, N.M. 295 pp.

2000 EXXON VALDEZ T 'EE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$0.0
Travel		$0.0
Contractual		$55.8
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$55.8
General Administration		$3.9
Project Total	$0.0	$59.7
Full-time Equivalents (FTE)		0.6
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		$24.6			

Dollar amounts are shown in thousands of dollars.

Comments:

FY00

Prepared:
BH Apr.2, 99

Project Number: 00433
Project Title: Effects of Forage Fish School Density and Species Composition on Foraging Patterns of Sea Birds: A Synthesis Product
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TI EE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$37.3						
Travel		$1.6						
Contractual		$5.2						
Commodities		$0.5						
Equipment		$0.0						
Subtotal	$0.0	$44.6			Estimated FY 2001	Estimated FY 2002		
Indirect		$11.2						
Project Total	$0.0	$55.8			$24.6			
Full-time Equivalents (FTE)		0.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

The indirect rate is 25% TDC, as negotiated by the *Exxon Valdez* Oil Spill Trustee Council with the University of Alaska.

FY00

Prepared:
E.Brown

Project Number: 00433
Project Title: Effects of Forage Fish School Density and Species Composition on Foraging Patterns of Sea Birds: A Synthesis Product
Name: Evelyn D. Brown

FORM 4A
Non-Trustee
SUMMARY

2000 EXXON VALDEZ T 'EE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2000
	Brown, E.	Principal Investigator/Program Manager	2.5	6.2		15.4
	Moreland, S.	Lab Technician	1.0	4.3		4.3
	Vallerino, M.	Programmer	1.0	5.0		5.0
	Blanchard, A.	Research Associate	2.5	5.0		12.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	7.0	20.5	0.0	
					Personnel Total	$37.3

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2000
	Fairbanks to Anchorage (Images)	220.0	1	4	121.0	0.7
	Anchorage to Fairbanks (Images)	220.0	1	4	125.0	0.7
	Car rental					0.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$1.6

FY00

Prepared:

Project Number: 00433
Project Title: Effects of Forage Fish School Density and Species Composition on Foraging Patterns of Sea Birds: A Synthesis Product
Name: Evelyn D. Brown

FORM 4B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ T 'EE COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
Communications	0.2
Publications	0.8
Copy/reporduction	0.2
Contract with Top Cover	4.0
Contractual Total	$5.2

Commodities Costs:	Proposed
Description	FY 2000
Software upgrades	0.5
Commodities Total	$0.5

FY00

Prepared:

Project Number: 00433
Project Title: Effects of Forage Fish School Density and Species Composition on Foraging Patterns of Sea Birds: A Synthesis Product
Name: Evelyn D. Brown

FORM 4B
Contractual & Commodities
DETAIL

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

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2000
Description			
			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		

FY00

Project Number: 00433
Project Title: Effects of Forage Fish School Density and Species Composition on Foraging Patterns of Sea Birds: A Synthesis Product
Name: Evelyn D. Brown

FORM 4B
Equipment
DETAIL

Prepared:

Project Title: Harbor Seal Recovery. Phase III: Effects of Diet on Lipid Metabolism and Health.

Submitted Under BAA No. 52ABNF800034

Project Number:	00441-BAA
Restoration Category:	Research
Proposer:	Randall Davis, Ph.D., Texas A&M University at Galveston
Lead Trustee Agency:	
Cooperating Agencies:	
Alaska SeaLife Center:	Yes
Duration:	2nd year, 2.5-year project
Cost FY 00:	$123,000 plus ADFG GA ($8.6K) = $131.6K
Cost FY 01:	$ 72,976 plus ADFG GA ($5.1K) = $78.1K
Geographic Area:	Prince William Sound and Alaska SeaLife Center
Injured Resource:	Harbor seals

ABSTRACT

The harbor seal population in Prince William Sound has not recovered and may continue to decline. An underlying hypothesis is that ecosystem-wide changes in food availability could be affecting harbor seal population recovery. To better understand the results from field studies of harbor seal health, body condition and feeding ecology, we need data for seals on diets that vary in nutritional composition. Working with the Alaska SeaLife Center, we will determine how fatty acid profiles in the blubber of captive harbor seals change over time during controlled diets of herring and pollock. In addition, we will assess the aerobic capacity and lipid metabolism of skeletal muscle in harbor seals fed controlled diets and for wild harbor seals in Prince William Sound. The results will augment already funded investigations of diet and health to provide a more in depth understanding of the nutritional role and assessment of dietary fat for harbor seals.

ACCOMPLISHMENTS FOR THE FIRST HALF OF YEAR ONE (SEPT. TO MAY 1999)

Feeding trials for eight harbor seals began in early September 1998 at the Alaska SeaLife Center. Four seals received a diet of herring and four a diet of pollock. Midway through the trial, blubber samples only were taken at two sites from each seal. At the end of this feeding trial (January 12), blubber and muscle biopsies were taken from two sites on each animal. Half of each muscle sample was placed in fixative, and the remainder along with the blubber samples were frozen at –70° C. The muscle samples were shipped to the University of California at San Diego where analysis (% fiber type, volume density of lipid droplets and mitochondria, lipid enzyme activities, and myoglobin concentration) is underway. The blubber samples will be analyzed for fatty acid profiles at Texas A&M University. This first feeding trial and the biopsies were completely successful. The second feeding trial is underway, and another series of biopsies will be taken in May 1999. No significant problems have been experienced, and we are on schedule. Preparations have been made for obtaining blubber and muscle samples from wild harbor seals in Prince William Sound as part of the BIOSAMPLING Program in June 1999.

INTRODUCTION

Understanding the feeding ecology and nutritional status of harbor seals (*Phoca vitulina richardsi*) is an essential component of ecosystem-based research on the recovery of species impacted by the Exxon Valdez oil spill in Prince William Sound. Until recently, determinations of prey preferences for pinnipeds have been based on stomach content and fecal analyses, both of which can only yield information on the most recent meals and may be biased due to differential rates of passage of food items. A new technique using fatty acid profiles of blubber can provide details on cumulative dietary history. It can also, in some cases, be used to determine foraging habitat. In pinnipeds, as with other carnivores and monogastric animals, dietary fatty acids generally remain intact through the digestion process and are deposited in adipose tissue with little or no modification (1). As a result, differences in the fatty acid composition of carnivore blubber can be used to infer dietary differences between individuals or populations and perhaps even species composition of the diet.

Previous research has shown that fatty acid signatures are significantly affected by spatial or temporal heterogeneity in habitat and food webs (1). In a study of harbor seal foraging ecology (Project 117-BAA; Harbor seal blubber and lipids) supported by the Restoration Program, Iverson, et al (2) were able to distinguish individual species of fish using fatty acid signatures. They also found fatty acid composition of these prey items to be correlated with body size as well as location within a study area. Hence, analysis of fatty acids in pinnipeds and their prey should provide details on the spatial scales of foraging and habitat use of both individuals and populations. Evaluating how harbor seal blubber fatty acids change with diet during controlled feeding studies where species composition of diet is known will improve the spatial and temporal interpretation of fatty acid profiles of wild seals whose diet composition is unknown.

Muscle condition and metabolic function can be used as indicators of the health status of marine mammals. Important indices of muscle function and health are aerobic capacity, the ability to store oxygen in the form of oxy-myoglobin and the size of lipid stores. In a preliminary study conducted by our laboratory (3), we observed that the volume density of mitochondria,

myoglobin concentration and citrate synthase activity in the swimming muscles of harbor seals were elevated relative to terrestrial mammals and appeared to be an adaptation for aerobic metabolism during diving. One objective of this study is to study the effect of diet on the aerobic capacity, myoglobin concentration and lipid stores of skeletal muscles in harbor seals. In addition, we will measure the activities of citrate synthase and *B*-hydroxyacyl CoA dehydrogenase (an enzyme important for lipid metabolism) as indicators of aerobic capacity and the *B*-oxidation of fatty acids, respectively.

The Restoration Program has supported the population monitoring component of health assessment, diving behavior and food preferences of harbor seals in Prince William Sound. Now, with controlled feeding studies of harbor seals underway at the Alaska SeaLife Center, we will continue our studies of the effects of diet on fatty acid signatures in blubber and the metabolic function of muscle, especially with regards to lipid. The results will improve our understanding of harbor seal feeding ecology and the effects of diet on health and metabolism.

NEED FOR THE PROJECT

A. Statement of Problem

The Restoration Program has supported three harbor seal studies in Prince William Sound (Project 001- Harbor seal condition and health status; Project 064- Monitoring habitat use and trophic interactions of harbor seals; Project 117-BAA- Harbor seal blubber and lipids). One objective of these studies has been to measure health and body condition indices related to metabolic alterations that might occur in animals that were food deprived. Although these studies collected much useful information, some researchers realized that controlled dietary studies were needed to more completely interpret field data. In 1997, the Restoration Program funded a captive study (Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet) at the Alaska SeaLife Center that will quantify the nutritional value of several key Alaskan fish species for harbor seals and will follow health indices over time in both healthy and rehabilitation animals. That project, which has been underway at the ALASKA SEALIFE CENTER for six months, will feed controlled diets of fish to harbor seals to examine changes in body condition, health, assimilation efficiency and blood chemistry biomarkers. Of particular interest will be the health and body condition effects of diets containing nutritionally poor (compared to herring) fish such as pollock, the so-called "junk food" hypothesis for explaining the decline of certain pinniped stocks. In the proposed research, we will continue (one feeding Trial is completed and the second will be completed in May 1999) to take advantage of the controlled feeding studies at the ALASKA SEALIFE CENTER to examine the effects of diet on: 1) fatty acid markers in the blubber, 2) muscle condition and 3) lipid metabolism. In addition, we will use samples of blubber and muscle obtained by the BIOSAMPLING Program in Prince William Sound for comparison with captive seals fed known diets. This important work will augment already funded investigations of diet and health to provide a more in depth understanding of the nutritional role and assessment of dietary fat for harbor seals.

B. Rationale

The harbor seal population in Prince William Sound has not recovered and may continue to decline. An underlying hypothesis is that ecosystem wide changes in food availability could be affecting harbor seal population recovery. To better understand the behavioral and physiological results obtained from field studies of harbor seal health, body condition and feeding ecology supported by the Restoration Program, we need comparable data for seals on diets that vary in nutritional composition. In 1998, a captive study was begun at the ALASKA SEALIFE CENTER to quantify the health effects of feeding several key Alaskan fish species to harbor seals. We propose to augment this study by examining changes in fatty acid profiles in seal blubber and muscle lipid content during controlled feeding studies where fish species composition is known. In addition, we will quantify the aerobic capacity and activities of enzymes that are crucial for muscle lipid metabolism and which may be affected by nutritional stress.

C. Location

The experiments for this project will be conducted at the Alaska SeaLife Center in Seward. We will collaborate with existing projects that will examine the detailed metabolic alternations in stable isotope ratios (Schell/Project 170) and changes in body condition and health indices (Castellini/Project 341) in harbor seals that occur under different feeding regimes.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Native communities have assisted Field studies of harbor seals in conjunction with the BIOSAMPLING program (Project 96244). We will continue that collaboration by analyzing samples of muscle, blubber and other tissues taken as part of subsistence hunting

PROJECT DESIGN

A. Objectives

1. Determine how fatty acids in the blubber of captive harbor seals change over time during controlled diets of herring and pollock.

2. Measure the content and composition of lipid in muscle of captive harbor seals fed controlled diets and for wild harbor seals in Prince William Sound.

3. Assess the aerobic capacity and lipid metabolism of skeletal muscle in harbor seals fed controlled diets and for wild harbor seals in Prince William Sound.

B. Methods

1. Hypotheses to be Tested.

1. Null hypothesis: Fatty acid profiles in the blubber of harbor seals are not affected by the fatty acid composition of the diet.

   Alternative hypothesis: Fatty acid profiles in the blubber of harbor seals will be directly affected by the fatty acid composition of the diet and will change as the diet is altered.

   Methodology: Feed controlled diets of different fish species to captive harbor seals. Assess temporal changes in the fatty acid composition of the blubber by taking serial biopsies. Compare with samples obtained from the BIOSAMPLING program of wild harbor seals in Prince William Sound.

2. Null hypothesis: Mitochondrial volume density, myoglobin concentration, lipid content, and the enzymatic activities of citrate synthase and *B*-hydroxyacyl CoA dehydrogenase are not affected by diet.

   Alternative hypothesis: These variables of muscle condition and function are affected by changes in diet.

   Methodology: Feed controlled diets of different fish species to captive harbor seals. Assess temporal changes in these variables by taking serial muscle biopsies. Compare with samples obtained from the BIOSAMPLING program of wild harbor seals in Prince William Sound.

2. Harbor Seal Feeding Trials Conducted at the Alaska SeaLife Center (ASLC).

Animals. Eight harbor seals have been acquired by the ASLC for the feeding trials that began in September 1998. Dr. Michael Castellini (Research Director at ASLC) developed dietary protocols for EVOS Project 99341. During the staggered feeding trials, the diet will be changed every four months. During these dietary manipulations, we will obtain serial blubber samples every two months and muscle biopsies every four months from two sites on each animal.

Design for Feeding Trials. A detailed matrix of the feeding schedule developed by Dr. Castellini is shown below. The procedure will use a cross-over repeated measures approach and will allow statistical comparisons within any one group of seals between diet and season. Statistical software (SYSTAT) will be used to analyze the cross-over method. However, there are several considerations that must be addressed using this matrix.

CROSS-OVER REPEATED MEASURES ANOVA FEEDING TRIALS
FOR HARBOR SEALS

Period	Herring	Pollock	Condition
Sept-Dec 1998	Seals A,B,C	Seals D,E,F	Molting
Jan-April 1999	D,E,F	A,B,C	Spring
May-Aug 1999	A,B,C	D,E,F	Breeding
Sept-Dec 1999	D,E,F	A,B,C	Molting
Jan-April 2000	A,B,C	D,E,F	Spring
May-Aug 2000	D,E,F	A,B,C	Breeding

This feeding matrix allows each group of seals to experience a different diet at similar physiologically relevant times of the year. Group A,B,C for example, will receive a herring diet during the molting season in Year 1 and a high pollock diet in Year 2. After training during the summer of 1998, the seals accepted a pollock diet that was 75-80% pollock.

A problem with cross-over ANOVA designs is that residual or carry-over effects from previous treatments can complicate the analysis. We correct for this with long test periods and phased cross-overs. That is, since each feeding trial will last for four months, several weeks of diet switching will be allowed. This provides the additional advantage of allowing us to study the impact of the phased switch on blubber and muscle lipid content and composition, and on muscle lipid metabolism.

Blubber Biopsies. Blubber samples will be obtained through the full depth of blubber layer with a 6-mm punch biopsy inserted through a small incision in the skin. Samples will be immediately transferred to liquid nitrogen and stored at -70° C until analysis. Total lipids will be extracted in chloroform according to Folch et al. (4) as modified by Iverson (5). Fatty acid methyl esters (FAME) will be prepared from the purified lipid extracts using the Hilditch reagent (0.5 N H_2SO_4 in methanol). FAME for fish in the controlled diets will be obtained similarly from homogenates of individual food items. The methyl esters will be analyzed by temperature-programmed capillary gas-liquid chromatography. FAME will be identified and quantified using a combination of standard mixtures, including those identified using chromatography and an ion-trap mass detector. Individual fatty acids, expressed as weight percent of the total fatty acids, will be analyzed using classification and regression trees (CART) in S-plus (StatSci, Seattle), a non-parametric multivariate technique for classifying data. CART uses a series of algorithms to split data into groups as differently as possible, based on measures of deviance; the splitting continues in a tree-like form until a classification is made at a terminal node. The analysis of blubber fatty acids is already being conducted in our laboratory in collaboration with Dr. Sara Iverson (University of Halifax) as part of a feeding ecology study of Steller sea lions. This collaboration will continue during the proposed harbor seal study.

Muscle Biopsies. Two muscle samples of approximately 50 mg each will be collected with a 6 mm biopsy cannula (Depuy, Warsaw, Indiana) from both the swimming (*M. longissimus dorsi*) and non-swimming (*M. pectoralis*) muscles. Control samples will be collected from the *M. soleus*, a

predominantly slow oxidative muscle, of laboratory rats (*Sprague Dawley*) euthanized by cervical dislocation after 2-3 min of carbon dioxide anesthesia. Muscle samples will be placed either into 2% glutaraldehyde fixative or frozen in liquid nitrogen immediately upon collection. Samples will remain in the fixative for a minimum of 48 hours but no longer then 14 days before being transferred and stored in 0.1 M cacodylate buffer pH 7.4. Frozen samples will be stored at -70 ° C until analysis for citrate synthase activity, *B*-hydroxyacyl CoA dehydrogenase activity and myoglobin concentration.

Electron Microscopy of Muscle Samples. Fixed muscle samples will be rinsed in cacodylate buffer and post-fixed for 2 hours in a 1% solution of osmium tetra oxide. They will be stained 'en bloc' with 2% uranyl acetate overnight in a refrigerator. After dehydration with increasing concentrations of ethanol (50-100%), they will be passed through propylene oxide and increasing concentrations of epoxy (50-100%). The samples are finally embedded in fresh epoxy and allowed to polymerize overnight at 60 ° C. Thick sections (1 mm) will be cut with a Leica Ultratome and stained with toulidine blue to determine fiber orientation. Ultrathin (50-70 nm), transverse sections will be cut and contrasted with lead citrate from 4 randomly chosen blocks per muscle. Micrographs will be taken with a Phillips 201 transmission electron microscope. The number of micrographs per muscle analyzed will range from 25 and 40, yielding relative standard errors of less than 10% in all muscles. Determination of the volume density of mitochondria, myofibrils and lipid droplets will be performed at a final magnification of x19,250 using standard point counting procedures (6, 7). The electron microscopy will be conducted under the supervision of Dr. Odile Mathieu-Costello at the University of California at San Diego (see attached letter).

Citrate Synthase, B-hydroxyacyl CoA dehydrogenase and Myoglobin Assays of Muscle Samples. Frozen muscle samples will be weighed and then homogenized at 0° C in 1 ml of buffer containing 1 mmol L^{-1} EDTA, 2 mmol L^{-1} $MgCl_2$, and 75 mmol L^{-1} Tris-HCl, pH 7.6 at 25 ° C (8). The homogenates will be spun at 2,900 g for 30 minutes at 4° C. 500 ml from each supernatant will be prepared for myoglobin assay and the rest will be used for the analysis of citrate synthase. Citrate synthase and *B*-hydroxyacyl CoA dehydrogenase will be assayed on a Beckman DU series 64 spectrophotometer according to the method of Reed et al. (1994). Assay temperature will be maintained at 37 ° C using a constant temperature water bath and a water-jacketed cuvette holder. The assay conditions for citrate synthase (CS; EC 4.1.3.7) will be 50 mmol L^{-1} imidazole, 0.25 mmol L^{-1} 5,5-dithiobis (nitrobenzoic acid, DTNB), 0.4 mmol L^{-1} acetyl CoA, and 0.5 mmol L^{-1} oxaloacetate, at pH 7.5; DA_{412}, e_{412} = 13.6 (8). For *B*-hydroxyacyl CoA dehydrogenase (HAD; EC 1.1.1.35), the assay conditions will be 50 mmol L^{-1} imidazole, 1 mmol L^{-1} EDTA, 0.1 mmol L^{-1} acetoacetyl CoA, and 0.15 mmol L^{-1} NADH, pH 7.0 at 37° C; DA_{340}, e_{340} = 6.22 (9). Enzyme activities (mmol min^{-1} g^{-1} wet mass muscle) will be calculated from the rate of change in absorbance at the maximum linear slope. Myoglobin will be assayed according to the method of Reynarfarje (1963) with the following modifications. A portion (500 ml) of the supernatant is further diluted with 1 ml of phosphate buffer (0.04 M, pH 6.6). The resulting mixture is centrifuged for 50 min at 28,000 g at 4°C. The supernatant is bubbled with carbon monoxide for three min. Spectrophotometric absorbance will be measured at 538 and 568 nm, and the concentration of myoglobin in milligrams g^{-1} wet mass of muscle will be calculated as:

$$(Abs_{538} - Abs_{568}) \times 5.865 [(1.5/0.5) \times (\text{mass of sample})]$$

Statistical Analysis. Results will be expressed as the mean ± one standard error. We will use a cross-over repeated measures approach that will allow statistical comparisons within any one group of seals between diet and season. Statistical software (SYSTAT) will be used to analyze the cross-over method. The relative proportions of fatty acids from blubber samples of seals in the controlled feeding study will be used as a basis for generating tree-based models (using S-Plus; StatSci, Seattle) of groups or classes of samples such that new samples (obtained via BIOSAMPLING) can be compared with the modeled classes to decide their membership, i.e. obtain a classification of their "diet". Similarly, classification and regression trees will be used to screen the set of prey fatty acids and choose a subset of those fatty acids which can be used to classify the "diets" of seals based the patterns of fatty acid proportions in their blubber.

3. Blubber and Muscle Samples Obtained from the BIOSAMPLING Program in Prince William Sound.

The main swimming muscle of 10 harbor seals will be obtained during BIOSAMPLING Program. The entire muscle will be removed and weighed, and three transverse sub-samples will be taken along the muscle bundle. Each sub-sample of the swimming muscle will be precisely labeled for its orientation and location within the animal. These will then be further sub-sampled along points on a circular grid using a stainless steel borer, averaging 35 samples per muscle section. Cores of tissues weighing 200 and 300 mg will be removed for assay. A spectrophotometric technique will be used to determine myoglobin, citrate synthase, and *B*-hydroxyacyl CoA dehydrogenase concentration (see above for details). Detailed contour maps and statistical tests for all concentrations will be made using a PC based program S-Plus (Stat-Sci, Seattle). Blubber samples will also be obtained from the same approximate anatomical location as on animals used in the captive studies and stored frozen at -70 °C. Blubber samples will be analyzed according to the protocols described in Section 2 of this proposal.

SCHEDULE

A. Measurable Project Tasks for FY 99 (October 1, 1998 - September 30, 1999), FY 00 (October 1, 1999 - September 30, 2000) and FY 01 (October 1, 2000 - March 31, 2001)

Each feeding trial will take four months beginning in September, 1998.

1998	
September	Set up fatty acid analysis and muscle lipid and enzyme analysis
September-December	Trial 1 of staggered feeding protocol at ASLC. Obtain and analyze blubber and muscle biopsies. Status- completed on schedule.
1999	
January-April	Trial 2 of staggered feeding protocol. Obtain and analyze blubber and muscle samples. Status- underway and on schedule.

May-August	Trial 3 of staggered feeding protocol. Obtain and analyze blubber and muscle samples. Status- on schedule. Obtain blubber and muscle samples from wild harbor seals in Prince William Sound in conjunction with BIOSAMPLING Program. Status- planning is completed; field work will begin in June 1999.
September-December	Trial 4 of staggered feeding protocol at ASLC. Obtain and analyze blubber and muscle biopsies.
2000	
January-April	Trial 5 of staggered feeding protocol. Obtain and analyze blubber and muscle samples.
May-August	Trial 6 of staggered feeding protocol. Obtain and analyze blubber and muscle samples. Obtain blubber and muscle samples from wild harbor seals in Prince William Sound in conjunction with BIOSAMPLING Program.
September-December	Analyze data and begin preparation of Final Report and manuscripts
2001	
December-March	Complete Final Report and submit manuscripts. Two manuscripts are anticipated at this time.

Note: Samples will be analyzed in groups as they are received. For the fatty acid analysis, it is most efficient to analyze the samples from every two feeding Trials.

B. Project Milestones

FY 99:	Obtain and analyze blubber and muscle samples during feeding studies at ASLC. Complete analysis of muscle and blubber samples from first four feeding Trials and the BIOSAMPLING Program in Prince William Sound.
FY 00:	Continue to obtain and analyze blubber and muscle samples during feeding studies at ASLC; obtain and analyze blubber and muscle samples from seals in Prince William Sound in conjunction with BIOSAMPLING Program; analyze all data; begin preparation of Final Report and manuscripts.
FY 01	Complete Final Report and manuscripts by March.

C. Completion Date

This project will finish on March 31, 2001.

PUBLICATIONS AND REPORTS

Since this is a new project, there are no current publications from the proposed research. However, the results from a preliminary study of the aerobic capacity and lipid content of muscles from harbor seals in Prince William Sound will be published in the Journal of Applied Physiology in April 1999. We do not anticipate any referred articles in FY 99. However, by FY 2000 most of the data will be analyzed and manuscripts in preparation. Because samples will continue to be collected through August 2000, we request an additional six month (Sept. 2000 to March 2001) to complete data analysis and prepare the Final Report and manuscripts. We anticipate at least two publications by 2001 on the effects of diet on fatty acids in blubber and the aerobic capacity and lipid metabolism in harbor seal muscle.

PROFESSIONAL CONFERENCES

The PI requests funds to attend the annual EVOS workshops each year.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

We are working in close coordination with Dr. Michael Castellini (PI on Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet) and staff at the Alaska SeaLife Center (see attached letter). Dr. Castellini is supervising the controlled diet studies. We have coordinated our blubber and muscle samples with the veterinary staff at ASLC. Samples obtained from the BIOSAMPLING program will be coordinated with Ms. Monica Riedel of the Alaska Native Harbor Seal Commission.

PROPOSED PRINCIPAL INVESTIGATOR

Dr. Randall Davis
Dept. Marine Biology
Texas A&M University at Galveston
Galveston, TX 77553
Phone: 409-740-4712
Fax: 409-740-5002
email: davisr@tamug.tamu.edu

PRINCIPAL INVESTIGATOR

Randall Davis, Ph.D., specializes in the physiology and metabolism of marine mammals. He is a Professor of Marine Biology at Texas A&M University and has worked in this field for over 20 years. In 1989, Dr. Davis was the Project Leader for Exxon's Oiled Sea Otter Rehabilitation Program in Prince William Sound.

Publications by Dr. Randall Davis relevant to the proposed research:

Kanatous SB, Davis RW, DiMichele LV, Cowan DF. (1999) High aerobic capacities in the skeletal muscles of seals, sea lions and fur seals: An adaptation to diving hypoxia. Journal of Applied Physiology.

Davis RW (1995) Cleaning and Restoration of the Fur. In: Emergency Care and Rehabilitation of Oiled Sea Otters: A Guide for Large and Small Oil Spills Involving Fur-bearing Marine Mammals. (TM Williams and RW Davis, eds). University of Alaska Press.

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Castellini MA, Davis RW, Loughlin TR, Williams TM. (1993) Blood chemistries and body condition of Steller sea lion pups at Marmot Island. Marine Mammal Science 9:202-208.

Davis RW, Pierotti VR, Hubl, ST, Lauer SJ, McLean JW, Witztum JL, Young SG. (1991) Lipoproteins in Pinnipeds: Analysis of a High Molecular Weight Form of Apolipoprotein E. J Lipid Res 32:1013-1023.

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Davis RW, Williams TM, Kooyman GL. (1985) Swimming metabolism of yearling and adult harbor seals (Phoca vitulina). Physiol Zool 58:590-596.

Davis RW. (1983) Lactate and glucose metabolism in the resting and diving harbor seal (Phoca vitulina). J Comp Physiol 153:275-288.

OTHER KEY PERSONNEL

Dr. Odile Mathieu-Costello is a Research Physiologist at the University of California at San Diego. She is internationally recognized for her research on ultrastructure and function of skeletal muscle. Her role will include the electron microscopic determination of mitochondrial volume density and lipid droplet density in muscle samples. No salary is requested as she is supported by other funding.

Dr. Shane Kanatous is a NIH Post-doctoral Fellow at the University of California at San Diego. He has conducted research on the aerobic scope and enzymatic adaptations in the skeletal muscles of marine mammals. His role will be to measure the enzyme activities of citrate synthase and *B*-hydroxyacyl CoA dehydrogenase in muscle samples. No salary is requested because he is supported on a NIH Post-doctoral Fellowship.

Dr. Sara Iverson is on the faculty of the University of Halifax, Canada. She is a recognized expert in the field of fatty acid analysis. She will supervise the analysis of fatty acids in blubber samples obtained from harbor seals in this project. The analysis will be performed by a doctoral student in Dr. Davis' laboratory. No salary is requested for Dr. Iverson. However, we will need to purchase supplies for the analysis and provide travel for the student to work in Dr. Iverson's laboratory.

Students (TBA). There are several students (Ph.D.) and Research Assistants in the Davis laboratory who will participate on this project.

LITERATURE CITED

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10. Reynafarje, B. Method for the determination of myoglobin. *J. Lab. & Clin. Med.* 61: 138-145, 1963.

July 6, 1998

Sandra Schubert
Exxon Valdez Oil Spill Trustee Council
645 G Street, Suite 401
Anchorage, AK 99501-3451

Dear Sandra,

Enclosed is my revised proposal for Project Number 99441-BAA entitled "Harbor Seal Recovery: Effects of Diet on Lipid Metabolism and Health." Molly McCammon had requested an amplification of the feeding regime. This has been incorporated into the revised proposal along with some additional changes in the text to reflect the feeding regime. The feeding regime was designed by Dr. Michael Castellini at the Alaska SeaLife Center for Project Number 99341. We will be following his design. In addition to making changes to the proposal, I have attached just the feeding regime section for easier reference. If you have any questions, please call me at 409-740-4712.

Sincerely,

Randall Davis, Ph.D.

Revised Feeding Regime

2. Harbor Seal Feeding Trials Conducted at the Alaska SeaLife Center (ASLC).

Animals. Eight harbor seals have been acquired by the ASLC for the feeding trials. Dietary protocols have been developed by Dr. Michael Castellini (Research Director at ASLC) for EVOS Project 99341. In the event that our proposed study is funded, Dr. Castellini has already agreed to obtain blubber and muscle biopsies from the seals during the controlled phase (herring only) of the dietary studies during the summer 1998. Beginning in FY99, we would begin direct participation in the feeding studies. During the staggered feeding trials, the diet will be changed every four months. During these dietary manipulations, we will obtain serial blubber and muscle biopsies of not less than once per month from two sites on each animal.

Design for Feeding Trials. A detailed matrix of the feeding schedule has been developed by Dr. Castellini and is shown below. The procedure will use a cross-over repeated measures approach and will allow statistical comparisons within any one group of seals between diet and season. Statistical software (SYSTAT) will be used to analyze the cross-over method. However, there are several considerations that must be addressed using this matrix.

CROSS-OVER REPEATED MEASURES ANOVA FEEDING TRIALS
FOR HARBOR SEALS

Period	Herring	Pollock	Condition
Sept-Dec 1998	Seals A,B,C	Seals D,E,F	Molting
Jan-April 1999	D,E,F	A,B,C	Spring
May-Aug 1999	A,B,C	D,E,F	Breeding
Sept-Dec 1999	D,E,F	A,B,C	Molting
Jan-April 2000	A,B,C	D,E,F	Spring
May-Aug 2000	D,E,F	A,B,C	Breeding

Two seals (G,H) will be in a separate feeding trial. They will follow alternating four month periods of herring and pollock, but for these animals feeding frequency and total mass fed will be varied every two weeks. For these two animals, blubber biopsy samples will be obtained at the end of each two week feeding period. Since the biopsies are small (see below), this should not affect the animals' health.

This feeding matrix allows each group of seals to experience a different diet at similar physiologically relevant times of the year. Group A,B,C for example, will receive a herring diet during the molting season in Year 1 and a high pollock diet in Year 2. We will work during the summer of 1998 to establish the highest amount of pollock in a diet that will be accepted by the animals. We expect this to be at least 75-80% pollock.

A problem with cross-over ANOVA designs is that residual or carry-over effects from previous treatments can complicate the analysis. We correct for this with long test periods and phased

cross-overs. That is, since each feeding trial will last for four months, several weeks of diet switching will be allowed. This provides the additional advantage of allowing us to study the impact of the phased switch on blubber and muscle lipid content and composition, and on muscle lipid metabolism.

2000 EXXON VALDEZ TRI E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$0.0
Travel		$0.0
Contractual		$123.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$123.0
General Administration		$8.6
Project Total	$0.0	$131.6
Full-time Equivalents (FTE)		1.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

		Estimated FY 2001	Estimated FY 2002		
		$78.1			

Dollar amounts are shown in thousands of dollars.

Comments:

FY00

Prepared:

Project Number: 00441
Project Title: Harbor Seal Recovery Phase III: Effects of Diet on Lipid Metabolism and Health
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$47.5
Travel		$21.2
Contractual		$5.3
Commodities		$10.8
Equipment		$0.0
Subtotal	$0.0	$84.8
Indirect @ 45% ($84,828)		$38.2
Project Total	$0.0	$123.0
Full-time Equivalents (FTE)		1.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

		Estimated FY 2001	Estimated FY 2002		
		$73.0			

Dollar amounts are shown in thousands of dollars.

Comments:

Indirect Costs @ 45% of Modified Total Direct Cost. The indirect cost rate is a predetermined rate established by the Department of Health and Human Services dated 9/9/97.

Fringes are calculated @ 15.5% of Salaries and Wages for the Pricnipal Investigator and Research Assistant. 8.25% is the calculation for the Graduate Research Assistant. Included in the fringe category is a fixed rate for medical insurance. The rate is a calculation based on the percentage of effort. The Principal Investigator is calculated @ $370/mo. The Research Assistant and Graduate Research Assistant is calculated @ $298/mo.

FY00

Prepared:

Project Number: 00441
Project Title: Harbor Seal Recovery Phase III: Effects of Diet on Lipid Metabolism and Health
Name: Texas A&M Research Foundation

FORM 4A
Non-Trustee
SUMMARY

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2000
	R. Davis	Principal Investigator	3.0	8411.6		25,235.0
	Vacant	Research Assistant	6.0	2182.5		13,095.0
	Vacant	Graduate Research Assistant	3.0	3066.0		9,198.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	12.0	13660.1	0.0	
					Personnel Total	$47.5

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2000
	To Seaward, Alaska for research at Alaska SeaLife Center (4 people)	1200.0	4	120	100.0	16,800.0
	Car Rental in Seaward, Alaska	40.0	30			1,200.0
	To Anchorage, Alaska for EVOS workshop	1200.0	1	5	100.0	1,700.0
	To Halifax, Canada for gas chromatograph analysis	1000.0	1	5	100.0	1,500.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$21.2

FY00

Prepared:

Project Number: 00441
Project Title: Harbor Seal Recovery Phase III: Effects of Diet on Lipid Metabolism and Health
Name: Texas A&M Research Foundation

FORM 4B
Personnel
& Travel
DETAIL

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

Contractual Costs:	Proposed
Description	FY 2000
Gas Chromatograph analysis (To Be Named)	2,500.0
Electron Microscope analysis (University of California, San Diego)	2,500.0
Communications - Long Distance Telephone Charges	300.0
Contractual Total	$5.3

Commodities Costs:	Proposed
Description	FY 2000
Expendable supplies and chemicals	10,000.0
Shipping of blood for analysis	300.0
Publication and Page Charges	500.0
Commodities Total	$10.8

FY00

Project Number: 00441
Project Title: Harbor Seal Recovery Phase III: Effects of Diet on Lipid Metabolism and Health
Name: Texas A&M Research Foundation

FORM 4B
Contractual & Commodities
DETAIL

Prepared:

2000 EXXON VALDEZ TRI E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2000
			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	
Description	of Units	

FY00

Project Number: 00441
Project Title: Harbor Seal Recovery Phase III: Effects of Diet On Lipid Metabolism and Health
Name: Texas A&M Research Foundation

FORM 4B
Equipment
DETAIL

Prepared: