19.08.01 (11 of 16)

COMMUNITY-BASED, LONG-TERM POPULATION MONITORING OF HARBOR SEALS

Project Number:	00444
Restoration Category:	General Restoration
Proposer:	Alaska Native Harbor Seal Commission
Lead Trustee Agency:	Alaska Department of Fish and Game
Cooperating Agencies:	University of Alaska Southeast Alaska Department of Fish and Game
Duration:	Two years
Cost FY 00:	$99,398
Cost FY 01:	$93,245
Geographic Area:	Kodiak (Tugidak Island)
Injured Resource/Service:	Harbor seals; subsistence

ABSTRACT

This project will combine the expertise of Alaska Native hunters, University researchers, and Alaska Department of Fish and Game researchers in developing a long-term population monitoring protocol for a harbor seal colony that once was the largest in the EVOS area. A new method of monitoring population size and vital parameters of harbor seals in the EVOS area will be developed. Photographic identification of individuals, based on unique coat patterns, will be used to generate mark-recapture population estimates for harbor seals at Tugidak Island. Productivity and juvenile survival rates also will be estimated based on re-sightings of a large sample of known individuals.

INTRODUCTION

Harbor seal (*Phoca vitulina richardsi*) numbers in the Gulf of Alaska were declining when the *Exxon Valdez* oil spill occurred, and the spill is believed to have contributed further to the decline. Harbor seals probably are second only to walruses in numbers of marine mammals harvested each year for subsistence in Alaska (Garlich-Miller and Burn 1997; Fay and Bowlby 1994; Wolfe and Mishler 1996), and Alaska Natives remain concerned about the recovery of harbor seals. The Alaska Native Harbor Seal Commission (ANHSC) is actively involved in harbor seal research and management, and works closely with the National Marine Fisheries Service (NMFS). The NMFS and the Alaska Department of Fish and Game (ADFG), with partial support from the EVOS Trustee Council, are monitoring the harbor seal populations in Alaska with the most frequent surveys conducted in Prince William Sound (Frost et al. 1998). Seals are counted from the air in an effort, headed by the NMFS, to survey the entire range of harbor seals in Alaska (Loughlin 1992, 1993, 1994; Withrow and Loughlin 1995, 1996a, 1997). A second effort, headed by the ADFG, surveys selected sites where changes in the numbers of seals are taken to represent population-wide trends (Frost et al. 1996; Small et al. 1997, 1998). Those surveys are expensive and require sophisticated sampling designs. Accounting for variability in the proportion of a seal population out of the water and visible to be counted requires a series of replicate surveys (Frost et al. 1998) and/or an independent estimate, usually obtained telemetrically, of the proportion of seals out of the water (Huber et al. 1992; Withrow and Loughlin 1996b).

Recognizing the need for a long-term, cost-effective monitoring program for harbor seals in the Gulf of Alaska, the ANHSC is proposing to develop such an effort as a community-based project. In collaboration with hunters and subsistence users on Kodiak Island and with the University of Alaska Southeast (UAS) and the ADFG, we propose to establish a protocol for long-term monitoring of the seals on Tugidak Island, south of Kodiak Island. Tugidak Island was chosen as the monitoring site for several reasons: (1) it was a population center in the Gulf of Alaska with as many as 17,000 seals using the island forty years ago (Mathisen and Lopp 1963); (2) it is in the spill area; (3) seals are readily observed there because they rest on a beach immediately below 15-30 m high vertical bluffs; (4) population data for the island are available in a time-series spanning the past 40 years (Mathisen and Lopp 1963; Bishop 1967; Johnson 1976; Kelly 1979, 1981, Pitcher and McAllister 1981; Pitcher 1990, 1991; Jemison and Kelly 1995, 1996, 1997, in prep.; Jemison 1996, 1997; Jemison et al. 1998); and (5) the decline in recent decades was detected at Tugidak Island considerably in advance of other areas (Pitcher 1990).

Between 1960 and 1972, approximately 18,000 seals, almost all pups, were removed from Tugidak Island in a commercial harvest (Bishop 1967). Population models predicted that the population would start recovering by the mid 1970s (Pitcher 1990). Instead, the population began declining rapidly in the mid 1970s and, by the late 1980s, only 1,000 – 2,000 seals were left on the island. While the island is in the EVOS impacted area, the effect of the spill on the seal population there is not known. Since 1992, the population appears to have been increasing (Jemison and Kelly 1997, in prep.; Small et al. 1998).

The University of Alaska and the ADFG have been studying seals on the island since the mid 1970s, and they have a substantial, long-term database pertaining to population size and demography at this important site. We recently completed a study linking changes in demographic composition to apparent changes in food availability (Jemison and Kelly 1997). We will expand on that work using a newly developed method of photographically identifying individual seals in a mark-recapture study (Caughley 1977; Krebs 1999). We shall obtain annual estimates of population size, productivity, and first-year survival rates.

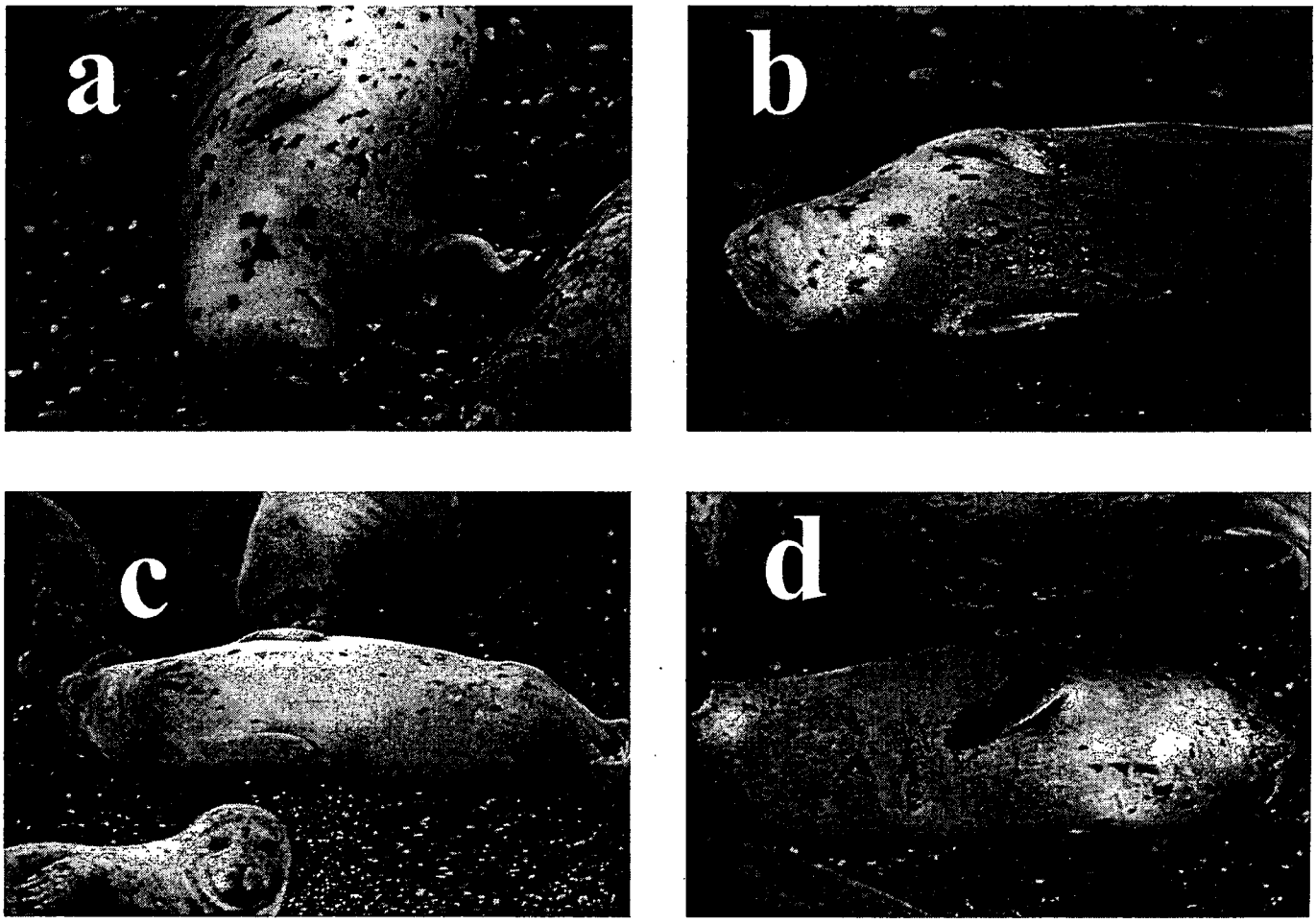
We began to develop a database of photographically "marked" seals in 1998 and will continue the effort in 1999. We have adapted a method of efficiently matching photographs of individual whales, using a computerized database, to match photographs of individual seals. Those seals' pelage patterns are unique and fixed for life like fingerprints (Stutz 1967; Yochem et al. 1985; B. P. Kelly, unpublished data), and identifying individuals repeatedly will allow us to greatly improve population estimation of the seal population at Tugidak Island and, perhaps, elsewhere. Over 500 seals were photographed in summer 1998 with a 35 mm camera and a 40X telescopic lens. The negatives were digitized and stored on compact disks. We have developed a preliminary vocabulary to describe the unique markings on each seals' pelage. Presently, we are testing the ability of observers to consistently categorize seals based on that vocabulary. Preliminary testing indicates that observers will be able to consistently score the color patterns with minimal training. We recently tested our preliminary scheme (Appendix 1) with 10 university students. Asked to score seals, they were unanimous in their scoring with a few exceptions; in those instances, one or more students indicated a seal was in one of two categories. In every case, those bracketed classifications overlapped with the single category chosen by the other students.

Once the classification scheme is refined, we will be able to enter the descriptions for each seal in to the database. Each record of the database will represent a photograph of a seal. Before entering new photographs in to the database, we shall determine whether the seal represented has previously been photographed by querying the database. The descriptions of the markings entered in to the database will allow the computer to select as possible matches only a small subset of the photographs in the database. That subset will be displayed on the computer screen, and the operator will visually determine which, if any, match the seal in the new photograph. The entry rate for the first 800 photographs was 200 photographs per day. By comparison, practiced operators enter 100-150 photographs per day in to the humpback whale photo-identification database maintained at the National Marine Mammal Laboratory in Seattle (S. Mizroch, personal communication).

Digitized photographs from annual samples will be compared, and individual seals present in both samples will be recognized based on their coat patterns. We already have identified individuals, based on coat pattern, that were photographed on more than one occasion last year (Figure 1). Thus, we now have the ability to accurately estimate population size based on mark-recapture data. The photographic method allows us to identify a large proportion of the individuals in the population without physically handling the seals. As a result, we will obtain very reliable population estimates for comparatively little money. Furthermore, the ability to follow known individuals over time will provide valuable information on age at first

reproduction, interval between pregnancies, juvenile survival rates, and other important population parameters. Such data represent an unparalleled opportunity in the study of harbor seal populations. At the same time, the community-based nature of the study will help bridge the gap between scientific and traditional knowledge (Huntington 1992).

Figure 1. A harbor seal photographically captured in August (a) and recaptured in September (b) 1998 on Tugidak Island. A second seal photographically captured (c) and recaptured (d) in September 1998. Note the individually unique markings on the pelage, especially in the neck region.



NEED FOR THE PROJECT

A. Statement of Problem

Harbor seals in the Gulf of Alaska and the Bering Sea declined substantially between the early 1970s and early 1990s (Johnson 1976; Kelly 1978; Hoover 1983; Pitcher 1990; Hoover-Miller 1994; Wilson and Jemison 1994; Wilson 1995; Jemison 1996; Moran and Wilson 1996; Withrow and Loughlin 1996; Frost *et al.* 1998). Within Prince William Sound, harbor seal numbers decreased 62% between 1984 and 1996 with part of that decline attributed to the 1989 *Exxon Valdez* oil spill (Frost *et al.* 1997). On Tugidak Island, however, harbor seals have increased 9% per year since 1992 (Small *et al.* 1998) with a 55% increase between 1994 and 1995 (Jemison and Kelly in prep.). Long-term monitoring of population demography indicated that changes in the timing of pupping and the age and sex composition of seals using Tugidak Island correlated with changes in population growth and appeared to be related to changes in food availability (Jemison 1997; Jemison and Kelly 1997, in prep.). Monitoring the recovery of the Tugidak Island population will be important to subsistence users and in comparison to the status of populations elsewhere within and outside of the EVOS area.

B. Rational/Link to Restoration

In recent years, subsistence users, researchers, and managers have increasingly realized the desirability of combining traditional and scientific knowledge of natural resources. To that end, in Spring 1999, the ANHSC and the NMFS will sign a plan for the co-management of harbor seals in Alaska. The draft plan calls for a bilateral "action plan for the conservation and co-management of subsistence uses of harbor seals in Alaska; to promote the sustained health of harbor seals in order to protect the culture and way of life of Alaska Natives who rely on the harvest of harbor seals for subsistence uses; to promote scientific research and the collection of data, including the traditional knowledge of Alaska Natives, in order to facilitate management decisions concerning harbor seals in Alaska." The ANHSC is active in the collection of biological samples and data from the subsistence harvest, and seeks to expand from a role in sample collection to a more active role in population monitoring. Models for combining traditional and scientific knowledge are increasing in number (Stevenson 1990; Ruddle and Johannes 1985; Huntington 1992; Fast and Berkes 1994; Ferguson and Messier 1997; McDonald *et al.* 1997), and the ANHSC is helping to chart new ground in this area. The ANHSC's biosampling program has been successful in providing important data to researchers while improving the subsistence users' education and appreciation of scientific data collection. This project will expand the research role of subsistence users to include collection and analysis of population data.

Long-term observations by ground-based observers have been very useful in monitoring the seasonal changes in population size and distribution, age and sex composition, and the timing of pupping and molting in harbor seals (Johnson 1974, 1975, 1976; Kelly 1981; Mathews 1992; Mathews 1995; Jemison 1997; Jemison and Kelly 1997, in prep.; Mathews and Pendleton 1997). Mathews and Kelly (1996), using ground-based observations, detected large scale, seasonal changes in the number of harbor seals in Glacier Bay – changes that were not detected in aerial

surveys (Loughlin 1994). Tugidak Island is ideally suited for ground-based studies, because seals are concentrated on a beach directly beneath 15 – 30 m high, vertical cliffs.

Jemison and Kelly (in prep.) made daily counts of seals resting on shore and scored the seals for sex and age class (pup of the year, yearling, and older) using binoculars or spotting scopes. On Tugidak Island, they documented a 1 to 3 week delay in pupping during a phase of population decline. Pupping shifted back to an earlier period when the population began to increase again in the early 1990s. Increased rates of pup abandonment, a decreased time ashore by seals that were not molting or tending young, and a decreased availability of preferred forage species were also associated with the declining phase of the population (Jemison and Kelly in prep.).

This study will monitor the recovery of harbor seals on Tugidak Island and employ, for the first time, photographic identification of individuals to monitor a harbor seal population.

C. Location

Data will be collected at Tugidak Island, one of the Trinity Islands in the Kodiak Archipelago. Quantifying population trends at Tugidak Island will provide a valuable contrast to trends in Prince William Sound and may help discriminate between possible causes of the continued decline in the latter area.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Community-based Research and Education

In 1995, the Alaska Native Harbor Seal Commission (ANHSC) was formed to increase the role of Alaskan Native resource policy in affecting harbor seals and their uses. One the organization's major goals is to encourage Native peoples to become more involved in research programs through the activities of subsistence hunters and students familiar with, or interested in, harbor seal ecology.

Through interactive educational workshops, hunters and students will be trained in basic harbor seal biology, current research activities, and a variety of collection protocols regarding biological sampling, population estimation, and behavioral observations. A "short course" will be offered for college credit through the University of Alaska Southeast in Kodiak Island communities. In return, researchers teaching the course will gain valuable information regarding local harbor seal abundance, location, and behavior. Trained individuals will be able to accomplish several tasks, including: (1) photographically "capturing" seals, (2) participating in ground-based surveys during pupping and molting, (3) distinguishing color phases, molt phases, age, and gender of harbor seals, and (4) analyzing population data using mark-recapture techniques.

Integrating subsistence hunters and users into research accomplishes several objectives. It promotes (1) a greater understanding of the results of scientific studies, (2) greater stewardship of

resources, (3) the opportunity for the incorporation of local and traditional knowledge in the interpretation of results, (4) the establishment of a trained, local work force able to cost-effectively continue studies as research funds decline, and (5) opportunities for local residents and students to receive college credit as they train as professional technicians and biologists.

The ultimate goals of these activities are to encourage subsistence hunters and users to become more involved in harbor seal research in the *Exxon Valdez* oil spill areas and to educate those individuals interested in careers in science. Experienced hunters, who have received specialized training, will be able to integrate that knowledge with existing skills to assist with current studies and to implement original research. Through internships, youth interested in biology as a profession, such as high school seniors and college students, can gain practical and valuable experience in field research. A trained Native workforce will be able to conduct cost-effective research over a broad geographic range, providing an unique integration of scientific methods and local knowledge.

PROJECT DESIGN

A. Objectives

(1) To actively involve hunters and subsistence users in harbor seal population research.

(2) To monitor population recovery of harbor seals resting on Tugidak Island.

(3) To monitor the productivity of harbor seals on Tugidak Island.

(4) To monitor rates of first-year survival of harbor seals in the Gulf of Alaska.

(5) To determine the degree of site fidelity at Tugidak Island by sex and age class.

B. Methods

Objectives 1: Involving hunters and subsistence users in harbor seal population research.

Hunters and subsistence users will be trained in data collection and analysis. The University of Alaska Southeast, a leader in distance education, will provide training from Juneau using the Internet, video conferencing, and local workshops in at least three communities on Kodiak Island (tentatively Old Harbor, Akhiok, and Ouzinkie). Training will continue on the island during data collection. Data entry and analyses are portable and will take place both in local communities and on the Juneau campus of the University of Alaska Southeast. Carrying out those functions in the local communities will make them accessible to a greater number of subsistence hunters and users and will be an important step in eventually basing the population monitoring effort in those communities. Selected high school students from the communities will be trained in data analysis on the Juneau campus in order to encourage their future enrollment in higher education.

Objective 2: Monitoring population recovery of harbor seals resting on Tugidak Island.

The number of harbor seals on the main haulout (southwest beach) will be estimated using two methods. The first method, will be that used in most of the previous population estimates at Tugidak Island (Pitcher 1990; Jemison 1997). Seals will be counted from atop the bluffs as close to low tide as is practical each day during the pupping season. Gender will be recorded based on the presence or absence of a penile opening for all seals for which the ventrum is visible. Pups will be identified by their small size, bright pelage, and association with their mothers. Yearlings will be recognized as the smallest seals, excluding pups, with bleached pelage and indistinct markings in early summer. Seals larger than yearlings will be classified either as subadults or adults based on size and degree of scarring (Jemison et al, 1998). The maximal number of seals present during a nine-day period centered on the day on which the most pups are observed will be taken as the index of population size for each year (Jemison and Kelly, in prep.).

We will also develop and test a mark-recapture method of estimating the population size at Tugidak Island. In their simplest form (the Petersen method), mark-recapture estimates assume that the proportion of all marked individuals observed in a second sample is equal to the proportion of the entire population represented by the number of individuals (marked + unmarked) observed in the second sample (Ricker 1975). Thus, the number of individuals (N) in the population can be calculated as

$$N = CM/R$$

Where M = number of individuals originally marked
C = number of individuals recaptured
R = number of marked individuals recaptured

The Petersen and related methods assume that during the study period the population size does not change due to births, deaths, immigration, or emigration (closed population). We expect changes in population size during the study, and we will use the Jolly-Seber method for open populations (Jolly 1965, 1982, Seber 1982). Details of the estimation procedure are presented in (Krebs 1999).

We will not physically capture and mark the seals; rather, all captures and recaptures will be done photographically in a manner similar to the methods used in mark-recapture studies of whales (Katona et al. 1979). We will rely on the individually unique markings on the seals' pelage to identify individuals.

Seals will be "marked" when their ventral surfaces are photographed using high-speed, black-and-white film (Figure 1). A seal will be considered to have been "recaptured" when it is photographed in subsequent samples. The actual match will be done by eye, but a computerized database will be used to minimize the number of photographs that need be examined to determine whether or not a new image represents a seal previously "captured" (Mizroch and Bigg 1990, Mizroch et al. 1990).

The Jolly-Seber method of estimating populations relies on four assumptions:

1. Marked and unmarked animals have the same probability of being recaptured
2. All marked animals have equal probabilities of survival
3. Marks are permanent
4. Sampling time is brief in relation to the interval between samples

An important part of the development of this new method of monitoring population size will be examining initial samples for violations of these assumptions. We are optimistic, based on traditional and scientific knowledge, that the assumptions will hold. One of the advantages of using natural markings is that the first assumption is likely to be met. The seals are not aware of being photographed, so having been photographed previously is unlikely to influence their availability for future photographs. Nonetheless, we shall use our initial data set and Leslie's method to test the assumption of equal catchability (Krebs 1999).

Similarly, the act of photographing seals in no way changes their probability of survival, and we expect the second assumption to be met.

Assumption 3 is difficult to meet with tags applied to animals. Any tag (visual, radio, satellite, etc.) attached to an animal can fall off or become worn and unrecognizable (Siniff and Ralls 1988). Harbor seal pelage patterns, however, are genetically controlled (Kelly 1981), and the same markings reappear on the pelage after successive molts (Stutz 1967, Yochem et al. 1985, B. P. Kelly, unpublished data). The only time the seals' natural markings are obscured is when the pelage is bleached by the sun just prior to the annual molt (Kelly 1979). Thus, it will be important to draw our samples before and after the pre-molt period.

The photographic method also has the advantage of quickly "capturing" seals. Our sample sessions will last a few hours, essentially instantaneous in contrast to the interval between samples, and we are confident that the fourth assumption of the Jolly-Seber method will be met.

Objective 3: Monitoring the productivity of harbor seals on Tugidak Island.

We shall use the observed number of pups on the island during May and June and our population estimate to calculate the birth rate each year. Generally, the precision of Jolly-Seber estimates increases with increasing capture probabilities, but the precision of estimating birth rates increases more slowly than does the precision of population size estimates. Our first attempts at photographically capturing seals on Tugidak Island in 1998 indicated capture probabilities between 0.20 and 0.58. At the latter probability of capture, the coefficients of variation would be less than 0.20 for estimates of birth rate and less than 0.10 for estimates of population size (Krebs 1999).

Objective 4: Monitoring rates of first-year survival of harbor seals in the Gulf of Alaska.

Pups and yearling seals are readily distinguished in the field (Kelly 1981; Hoover 1983; Jemison 1997), and we will be able to estimate population size for each of those age classes annually. Given our preliminary estimates of capture probabilities, we conservatively estimate that our coefficient of variation for estimates of first-year survival will be between 0.05 and 0.15 (Krebs 1999).

Objective 5: Determine the degree of site fidelity at Tugidak Island.

Over several years, the database of photographically identified seals will permit us to follow the history of individual seals over time. We shall use the frequency of seals (excluding pups) seen for the first time at Tugidak Island in estimating the rate of immigration. The proportion of seals returning to the island in years after they were originally photographed will permit inferences about site fidelity, although it will not be possible to rule out mortality.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The University of Alaska Southeast will provide research guidance and instruction in scientific knowledge of harbor seal population biology. The ADFG will provide a cabin to house researchers on Tugidak Island, and they will collaborate in the collection of field data. The U. S. Coast Guard has kindly provided helicopter transportation to and from Tugidak Island to support our research in recent years. We expect the same support during this project.

SCHEDULE

A. Measurable Project Tasks for FY00 (10/1/00 to 9/30/01)

DATE	GOAL
February:	Complete analysis of preliminary photographic samples, and develop draft sampling protocol for 2000 and 2001.
March:	Obtain reviews of protocol by ADFG and knowledgeable population biologists.
April:	Conduct population biology short-course in Kodiak Island communities.
May-August:	Field data collection; pupping phenology, age/sex composition counts, photographic "tagging" of individuals.
Sept-Dec.:	Analyze field data and compile year-end report.

B. Project Milestones and Endpoints

FY '00

Feb 15:	Draft sampling protocol submitted to cooperators and reviewers.
March:	Receive written reviews, and prepare final protocol.
April 10 – 30:	Teach population biology short-course in communities.
May 15 – June 15:	Monitor pupping phenology and obtain first photographic samples of season on Tugidak Island.
Aug. 1 – Sep. 1:	Field data collection: age/sex composition counts. Additional photographic sampling. Identification of previously photographed ("tagged") individuals.
Sept. 30:	Finish year-end report for '00.
Oct. 15 – 20:	Post-field season workshop: identification of, and remedies for, data protocol problems; report to communities

FY '01

Oct. 30 – Jan. 30:	Complete analysis of data collected from FY '00. Training of community-based researchers in data analysis and interpretation.
April 10 – 15:	Training and coordinating workshop (Cordova); Community-based researchers, ANHSC, University of Alaska, and ADFG
May 20 – July 1:	Field data collection; pupping phenology, age/sex composition counts, and photographic "tagging" of individuals
Aug. 1 – Sep. 1:	Field data collection: complete age/sex composition counts and photographic "tagging". Identification of previously photographed ("tagged") individuals.
Sept. 30:	Complete analysis of data collected during FY '01for year-end report
October	Begin comparison of '00 and '01 data .
Oct. – Nov.	Complete estimation of population size, productivity, and first-year survival.
Dec. :	Complete data analysis, prepare final report, submit for publication

C. Completion Date

It is anticipated that by December, 2001 we will have determined and recommended a cost-effective, long-term population monitoring program for harbor seals on Tugidak Island.

PUBLICATIONS AND REPORTS

These findings will be published in Marine Mammal Science at the completion of the project in December, 2001.

PROFESSIONAL CONFERENCES

The results of this study will be presented at the biennial conference for marine mammals as well as at EVOS meetings.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will be coordinated with hunters and subsistence users on Kodiak Island through the ANHSC. Native peoples will play a vital role in data collection and analysis. Their local knowledge of harbor seal behavior will be used in sampling design and data interpretation. Trained student interns will help collect, analyze, interpret, and synthesize information.

Data collection will also be coordinated with ADFG. The University subcontractor and the ADFG have been collaborating on population studies at Tugidak Island for over 20 years, and they will continue to coordinate research efforts and share camp facilities, equipment, and technical staff. Two University of Alaska Southeast students have conducted the majority of the fieldwork on Tugidak Island for the past two years, and they will do so again in 1999. At present, both of those students are analyzing data from Tugidak Island at the University. One is paid as a Student Intern (supervised by Lauri Jemison and Dr. Robert Small) with ADFG, the other paid as a Student Intern (supervised by Dr. Kelly) with the ANHSC.

The ADFG is exploring an alternate form of photographically sampling harbor seals (Hiby 1990). That method relies on photographs of the seals' heads digitized and stored on a computer. A computer program then corrects for differences in viewing angles based on land-mark features on the face. The computer then compares densities of images in selected areas to determine a match between two images. That method and the visual match method proposed here both have potential advantages. The method being explored by ADFG requires that fewer variables be entered into a computer database, a potential savings in time, and the necessary software has already been developed (Hiby 1990). The necessary views of the heads, however, require greater field time waiting for the animals to face the camera. In the preliminary investigation in 1998, the time required to get a usable photograph of the head was about twice the amount of time required to obtain a photograph of the ventrum usable for the method proposed here. An additional difficulty in obtaining head views was that the seals, by definition, had to be looking at the camera, and they did so mainly when they were moving up the beach on an in-coming tide. As a result, sampling was limited to a narrow window of time when the animals were active.

Being active and oriented toward the camera also meant they were more likely to detect and be disturbed by the photographers. The net result may be a lower capture rate and, therefore, lower precision in mark-recapture estimates. It must be emphasized, however, that these conclusions, based on preliminary results, are tentative, and we believe both methods should be further developed. Each method may have utility at different sites and under different circumstances. The one with the most utility at Tugidak Island will be determined only when the true trade-offs between sampling time and sample size are known for each method.

PROPOSED PRINCIPAL INVESTIGATORS

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PRINCIPAL INVESTIGATOR

Monica Riedel, an Alaska Native resident of Cordova, is the executive director of the Alaska Native Harbor Seal Commission. Ms Riedel is responsible for the ANHSC activities under this project, including identifying and subcontracting community-based researchers, arranging travel, and organizing meetings and workshops. No restoration funds are requested for Ms Riedel's involvement in this project.

Brendan P. Kelly is an Assistant Professor of Biology and Program Coordinator at the University of Alaska Southeast and of Fisheries at the Juneau Center, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks. Dr. Kelly will be responsible for the educational and scientific coordination of the project including short course delivery, sampling design, data analysis, and reporting.

OTHER KEY PERSONNEL

Brian Taras will be the project biometrician. He has an extensive background in physical and biological sciences and holds a M.S. in Geology/Geochemistry from Massachusetts Institute of Technology and a M.S. in Statistics from the University of Alaska Fairbanks. He will assist in development of the most appropriate mark-recapture design and in data analysis.

A graduate student in Marine or Fisheries Biology will be recruited to coordinate the field effort, to assist in community education, and to participate in all phases of the project.

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Loughlin, T. R. 1993. Abundance and Distribution of Harbor Seals (*Phoca vitulina richardsi*) in the Gulf of Alaska and Prince William Sound During 1992. Annual Report for 1992 under the NMFS, MMPA Population Assessment Program submitted to the Office of Protected Resources, NMFS, NOAA.

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Small, R. J., G. W. Pendleton, and K. Wynne. 1998. Harbor seal population trends in the Ketchikan, Sitka, and Kodiak Island areas of Alaska. Pages 7-26 *in* R. J. Small, editor. Harbor Seal Investigations in Alaska, Annual Report, NOAA Grant NA57FX0367. Division of Wildlife Conservation, Alaska Department of Fish and Game, Anchorage, Alaska.

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Withrow, D. E., and T. R. Loughlin. 1996a. Abundance and distribution of harbor seals (*Phoca vitulina richardsi*) along the north side of the Alaska Peninsula and Bristol Bay during 1995. Pages 67-88 *in* Marine Mammal Protection Act and Endangered Species Act Implementation Program 1995, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910. [Available from National Marine Mammal Lab, 7600 Sand Point Way, NE, Seattle, WA 98115].

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Silver Spring, MD 20910. [Available from National Marine Mammal Lab, 7600 Sand Point Way, NE, Seattle, WA 98115].

Withrow, D. E., and T. R. Loughlin. 1997. Abundance and distribution of harbor seals *Phoca vitulina richardsi* along the south side of the Alaska Peninsula, Shumigan Islands, Cook Inlet, Kenai Peninsula and the Kodiak Archipelago in 1996. Pages 119-155 *in* Marine Mammal Protection Act and Endangered Species Act Implementation Program 1997, Office of Protected Resources, NMFS, NOAA, 1335 East-West Highway, Silver Spring, MD 20910.

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BUDGET:

	FY '00	FY '01
PERSONNEL		
Community-based researchers (90 person-days @ $150/day)	$13,500	
Community-based researchers (100 person-days @ $150/day)		$15,000
TRAVEL		
To Study Sites (8 tickets @ $400 per person)	$ 3,200	$ 3,200
To EVOS meetings	$ 1,200	$ 1,200
Supplies		
Field camp supplies	$ 500	$ 500
Field groceries	$ 3,600	$ 3,600
SERVICES		
Film developing (56 rolls @ $10)	$ 560	$ 560
Image digitizing (2000 images @ $1)	$ 2,000	$ 2,000
UNIVERSITY OF ALASKA CONTRACT		
Salary and benefits, Brendan P. Kelly (2 mo.)	$11,000	$11,000
Stipend (graduate student) $21,300 + $2,844 tuition per year	$24,144	$24,144
35 mm camera	$ 1,000	
Telescopic lens	$ 3,000	
Field computer	$ 2,500	
Indirect Costs (35%)	$12,650	$12,300
SOLID SOLUTIONS SUBCONTRACT		
Salary and benefit for Brian D. Taras, biometrician (1.5 mo.)	$ 6,264	$ 6,264
Indirect Costs (21%)	$ 1,315	$ 1,315
SUBTOTAL	$86,433	$81,083
INDIRECT COSTS: ANHSC (15%)	$12,965	$12,162
TOTAL	$99,398	$93,245

CURRICULUM VITAE

BRENDAN PATRICK KELLY

S.S. # 572-82-7826

Mailing Address: Biology Program
University of Alaska Southeast
11120 Glacier Highway
Juneau, AK 99801

Born: 18 January 1952, New York, New York, U.S.A.

Education:
B.A. University of California Santa Cruz, 1975 (Biology)
M.S. University of Alaska Fairbanks, 1979 (Biology)
Ph.D. Purdue University, 1996 (Biology)

Professional Memberships:
American Society of Mammalogists
The Society for Marine Mammalogy (Charter Member)
Arctic Institute of North America (Life Member)
International Society for Behavioral Ecology
Sigma Xi
National Center for Science Education
National Association of Underwater Instructors - SCUBA

Awards and Fellowships:
Ida L. Goebel Research Grant
University of California Santa Cruz - 1974

NSF Undergraduate Research Fellow
Stanford University - 1974

Highest Honors in Biology
University of California Santa Cruz - 1975

Research and Advanced Study Grants
University of Alaska Fairbanks - 1977 and 1978

David Ross Fellow
Purdue University - 1990-1992

Professional Experience:

Assistant Professor of Biology & Program Coordinator, Univ. of Alaska Southeast, 1996-present
Assistant Professor of Fisheries, University of Alaska Fairbanks, 1996-present
Research Associate, Institute of Marine Science, University of Alaska, Fairbanks, 1982 - 1996
Research Assistant, Biological Sciences, Purdue University, West Lafayette, IN, 1990 - 1991
Teaching Assistant, Biological Sciences, Purdue University, West Lafayette, IN, 1989
Marine Mammals Biologist, Alaska Department of Fish and Game, Fairbanks, 1981-1982
Biological Technician, Institute of Arctic Biology, University of Alaska, Fairbanks, 1980
Biological Technician, National Marine Mammal Laboratory, Seattle, Washington, 1980
Research Assistant, Division of Life Sciences, University of Alaska, Fairbanks, 1978-1980
Teaching Assistant, Biological Sciences Program, University of Alaska, Fairbanks, 1977
Biological Technician, Alaska Department of Fish and Game, Gulf of Alaska, 1977
Teaching Assistant, Biological Sciences Program, University of Alaska, Fairbanks, 1976
Field Operations Manager, Environmental Research Consultants, Watsonville, CA 1975-1976
Biological Researcher, University of California, Gulf of California, Mexico, 1974-1975
Biological Researcher, Stanford University, Hopkins Marine Station, Monterey, CA, 1974

Service:

Alaska Native Harbor Seal Commission advising: 1995 - present

Alaska Scientific Review Group - marine mammal stocks (NMFS/USFWS): 1994 - present

Marine Mammal Working Group Steering Committee, U.S.- Russia Environmental Agreement: 1996 - present

Graduate student advising:

Gay Sheffield (M.S. 1997) - Walrus feeding - a re-examination. MS Thesis. University of Alaska Fairbanks.

Lauri Jemison (M.S. - 1997) - Recent history and demography of harbor seals on Tugidak Island, Gulf of Alaska. MS Thesis. University of Alaska Fairbanks.

Michael Simpkins (Ph.D. program) - Ringed seal foraging ecology

Dion Oxman (Ph.D. program) - Foraging ecology of juvenile Steller sea lions

Stephanie Haverlack (M.S. program) - Diving behavior of sea otters

Publications:

Jemison, L. A., and B. P. Kelly. in prep. Pupping phenology, productivity, and juvenile survival of harbor seals on Tugidak Island, Gulf of Alaska.

Kelly, B. P., D. Wartzok. in prep. Diving behavior of ringed seals in shore-fast ice: test of optimal allocation of time hypotheses.

Fay, F. H., L. L. Eberhardt, B. P. Kelly, J. J. Burns, and L. T. Quakenbush. 1997. Status of the Pacific walrus (*Odobenus rosmarus divergens*) population, 1950-1989. Marine Mammal Science 13:537-565.

Kelly, B. P. 1996. Live capture of ringed seals in ice-covered waters. J. Wildl. Manage. 60:678-684.

Mathews, E. A., and B. P. Kelly. 1996. Extreme temporal variation in harbor seal (*Phoca vitulina richardsi*) numbers in Glacier Bay, a glacial fjord in Southeast Alaska. Marine Mammal Science 12:483-489.

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Kingsley, M. C. S., M. O. Hammill, and B. P. Kelly. 1990. Detecting ringed seal lairs by the heat they radiate. Marine Mammal Science. 6:339-347.

Kelly, B. P. 1990. Tooth-walker, unique mammal of the arctic. Anima 216:28-31.

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Elsner, R., D. Wartzok, N. B. Sonafrank, and B. P. Kelly. 1989. Behavioral and physiological reactions of arctic seals during under-ice pilotage. Can. J. Zool. 67:2506-2513.

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Kelly, B. P. 1988. Ribbon seal, *Phoca fasciata.* Pages 97-106 *in* J. W. Lentfer, ed. Selected marine mammals of Alaska: species accounts with research and management recommendations. Marine Mammal Commission, Washington, D.C.

Kelly, B. P. 1988. Bearded seal, *Erignathus barbatus.* Pages 77-94 *in* J. W. Lentfer, ed. Selected marine mammals of Alaska: species accounts with research and management recommendations. Marine Mammal Commission, Washington, D.C.

Kelly, B. P., J. J. Burns, and L. T. Quakenbush. 1988. Responses of ringed seals (*Phoca hispida*) to noise disturbance. Pages 27-38 *in* W. M. Sackinger, M. O. Jeffries, J. L. Imm, and S. D. Treacy, eds. Port and Ocean Engineering under Arctic Conditions. Vol. II. Symposium on noise and marine mammals in ice-covered waters. Geophysical Institute, University of Alaska, Fairbanks.

Kelly, B. P., and L. T. Quakenbush. 1987. Trained dogs and wild seals. Whalewatcher, Journal of the American Cetacean Society 21(1):8-11.

Kelly, B. P. 1981. Pelage polymorphism in Pacific harbor seals. Can. J. Zool. 59:1212-1219.

Fay, F. H. and B. P. Kelly. 1980. Mass natural mortality of walruses (*Odobenus rosmarus*) at St. Lawrence Island, Bering Sea, autumn 1978. Arctic 33:226-245.

Reports and Abstracts:

Kelly, B. P., L. T. Quakenbush, G. G. Sheffield, and B. Taras. 1999. Population biology and trophics of the Pacific walrus. 1999 Gordon Research Conference on Controls and Significance of Carbon Fluxes in Polar Seas. Ventura, California. 7-12 March 1999.

Kelly, B. P., and D. Wartzok. 1998. Do predators cause seals to revise optimum foraging calculations? Abstract submitted to the World Marine Mammal Conference. Monaco. January 1998.

Bodkin, J. L., B. P. Kelly, and G. E. Esslinger. 1998. Sea otter diving depths and implications to fisheries. Abstract submitted to the World Marine Mammal Conference. Monaco. January 1998.

Jemison, L. A., and B. P. Kelly. 1995. Harbor seal productivity and juvenile survival in the Gulf of Alaska. 11th Bien. Conf. Biol. Mar. Mam., Abstracts, p. 58.

Kelly, B. P. 1995. Sea otter management plan for the Kodiak Island Region. Alaska Sea Otter Commission, Fairbanks, Alaska. 49pp.

Kelly, B. P. 1995. Management plans for the sea otter (*Enhydra lutris*) in the Aleutian - Pribilof Islands region. Alaska Sea Otter Commission, Fairbanks, Alaska. 49pp.

Kelly, B. P. 1995. Management plan for sea otters (*Enhydra lutris*) in the Bristol Bay region. Alaska Sea Otter Commission, Fairbanks, Alaska. 49pp.

Kelly, B. P. 1995. Southeastern Alaska regional management plan for sea otters (*Enhyrda lutris*). Alaska Sea Otter Commission, Fairbanks, Alaska. 53pp.

Kelly, B. P., J. Anthony, and L. A. Jemison. 1994. Status and trends of harbor seal and sea otter populations in Prince William Sound and Lower Cook Inlet, Alaska. Draft report to the Division of Subsistence, Alaska Department of Fish and Game. Anchorage, Alaska. 60pp.

Kelly, B. P. 1994. Sea otter management plan for the Chugach and Cook Inlet Regions. Alaska Sea Otter Commission, Fairbanks, Alaska. 46pp.

Kelly, B. P. 1993. Sea otters, shellfish, and indigenous people of Alaska, synecology in the present tense. 4th Joint U.S./Russia Sea Otter Workshop. Wasilla, Alaska. (Abstract).

Kelly, B. P. 1993. Conservation plan for Pacific harbor seals. 1993. Office of Protected Resources, National Marine Fisheries Service, Silver Spring, Maryland. 74pp.

Kelly, B. P. 1991. Conservation plan for the Pacific walrus (*Odobenus rosmarus divergens*). U.S. Marine Mammal Commission, Washington, D.C. 77pp.

Kimmerer, W., A. Small, J. Grebmeier, D. Roseneau, A. Springer, D. Musgrave, M. Willette, and B. Kelly. 1991. An ecosystem simulation model for Kasegaluk Lagoon, Alaska. Final Draft submitted to Minerals Management Service, Anchorage, AK.

Watanabe, K., Kawaguchi, K., Kelly, B. P. 1991. Report on marine biological research in ice-covered waters of the Beaufort Sea, March 1990. (In Japanese). Nankyoku shiryo: Nihon Nankyoku Chiiki Kansoku 35:262-269.

Kelly, B. P. 1990. Tooth-walker, unique mammal of the arctic. Anima 216:28-31.

Fay, F. H., B. P. Kelly, and B. A. Fay. 1990. The ecology and management of walrus populations. Report of an international workshop; 26-30 March 1990. Marine Mammal Commission, Washington, D.C. 190pp.

Kelly, B. P. 1990. Tracking ringed seals under the ice of Resolute Passage, N.W.T. - Spring 1990. Interim report to Fisheries and Oceans, Winnipeg and The Resolute Bay Hunters and Trappers Association, Resolute Bay, N.W.T., Canada.

Kelly, B. P., D. Wartzok, and L. T. Quakenbush. 1989. Under-ice range of ringed seals in the Beaufort Sea. 8th Biennial Conf. Biol. Mar. Mamm. Pacific Grove, CA (Abstract).

Fay, F. H., B. P. Kelly, J. L. Sease, and R. R. Nelson. 1989. Sampling the sex/age composition of walrus populations. 8th Biennial Conf. Biol. Mar. Mamm. Pacific Grove, CA. (Abstract).

Fay, F. H., and B. P. Kelly. 1989. Development of a method for monitoring the productivity, survivorship, and recruitment of the Pacific walrus population. Final Report, OCSEAP Study MMS 89-0012. Minerals Management Service, Anchorage, AK. 51pp.

Watkins, W. A., D. Wartzok, B. Würsig, B. P. Kelly, and K. Fristrup. 1989. Radio tracking of bowhead whales. 8th Biennial Conf. Biol. Mar. Mamm. Pacific Grove, CA. (Abstract).

Kelly, B. P., S. C. Amstrup, C. Gardner, and L. T. Quakenbush. 1987. Predation on ringed seals in the western Beaufort Sea. 7th Biennial Conf. Biol. Mar. Mamm., Miami, FL (Abstract).

Wartzok, D., R. Elsner, B. P. Kelly, G. Mimken, and L. T. Quakenbush. 1987. Visual, acoustic, and vibrissal contributions to under-ice navigation by ringed seals, *Phoca hispida*. 7th Biennial Conf.Biol. Mar. Mamm., Miami, FL (Abstract).

Zabel, C. J., S. J. Taggart, and B. P. Kelly. 1987. A comparison of aggressive behavior in female and male walruses (*Odobenus rosmarus*) during the fall migration. 7th Biennial Conf. Biol. Mar. Mamm. Miami, FL. (Abstract).

Fay, F. H., B. P. Kelly, P. H. Gehnrich, J. L. Sease, and A. A. Hoover. 1986. Modern populations, migrations, demography, trophics, and historical status of the Pacific walrus. NOAA, OCSEAP, Final Reps. Principal Investigators 37:231-376.

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Kelly, B. P., L. T. Quakenbush, and J. R. Rose. 1986. Ringed seal winter ecology and effects of noise disturbance. Final report to OCSEAP, RU #232, Part 2. 83pp.

Kelly, B. P., L. Quakenbush, and J. R. Rose. 1985. Telemetric studies of winter habitat use by ringed seals. 36th Alaska Science Conference. (Abstract).

Kelly, B. P. 1985. Dependence by ringed seals on subnivean lairs. Sixth Biennial Conference on the Biology of Marine Mammals. (Abstract).

Kelly, B. P. 1983. Ringed seal snow lairs: use patterns and thermal significance. Fifth Biennial Conference on the Biology of Marine Mammals. (Abstract).

Burns, J. J. and B. P. Kelly. 1982. Studies of ringed seals in the Alaskan Beaufort Sea during winter: impacts of seismic exploration. Annual report to OCSEAP, RU232.

Burns, J. J., B. P. Kelly, and K. J. Frost. 1981. Habitat use and winter ecology of ringed seals. Part 2 of annual report to OCSEAP (NOAA), RU #232.

Kelly, B. P. 1979. Population and ecological genetics of pelage polymorphism in Pacific harbor seals. M.S. Thesis, Univ. Alaska, Fairbanks. 58pp.

Kelly, B. P. 1979. Pacific walrus. Unpublished species account, NOAA Outer Continental Environmental Assessment Program, Arctic Project Office. 13pp.

Kelly, B. P. and R. M. O'Connor. 1979. Walrus mortality studies on Round Island State Game Sanctuary, August 1979. Report to the Alaska Dep. Fish and Game.

Burns, J. J., L. H. Shapiro, F. H. Fay, B. P. Kelly, K. J. Frost, and L. F. Lowry. 1978. The relationships of marine mammal distribution, densities and activities to sea ice conditions. Annual report to OCSEAP (NOAA), RU #248/249.

Fay, F. H., R. A. Dieterich, L. M. Shults, and B. P. Kelly. 1978. Morbidity and mortality of marine mammals. Annual report to OCSEAP (NOAA), RU #194.

Kelly, B. P. 1978. Biological observations on Otter Island, Pribilof Islands, July 1978. A report to the National Marine Fisheries Service, Seattle.

Kelly, B. P. 1975. Report on a study of *Phocoena sinus*, Norris and McFarland 1958, and an attempt to collect a specimen. Marine Mammal Commission, Wash., D.C. 11pp.

CURRICULUM VITAE

BRIAN TARAS

Research Consultant in biometrics/statistics and environmental geochemistry
d.b.a. Solid Solutions since January 1999.

Research Associate, Univ. Alaska Fairbanks; Mathematics Dept./Inst. Northern Engineering

Education:

B.A. Geology, University of Pennsylvania, 1980 (Summa Cum Laude with honors)

M.S. Geology/Geochemistry, Massachusetts Institute of Technology, 1984
Thesis: "Sr, Nd and Pb Isotopes and Trace Element Geochemistry of the New England Seamount Chain" Advisor: Professor Stanley Hart.

M.S. Statistics, University of Alaska, Fairbanks, 1998

Experience:

As a research consultant and research associate at UAF, Mr. Taras applies statistical and mathematical methods to research in the physical, environmental, and biological sciences. These positions require functioning with a high level of independence, an ability to work with scientists in a variety of fields, and an ability to coordinate multiple projects. Mr. Taras is responsible for writing proposals to obtain grants and/or contracts. Mr. Taras works with Dr. Brendan Kelly on the population dynamics of pacific walrus and is continuing analysis of ringed seal diving data initiated while a graduate student. Mr. Taras provides statistical support for Ms. Lori Quakenbush, a UAF biologist, with her studies of walrus morphometrics, and the population dynamics and nesting habitat of Steller's eiders. He also assists Professor Jennifer McBeath, in UAF's Plant, Animal and Soil Sciences Department, with designing studies to test the effect of biological controls on plant pathogens and analyzes resulting data.

In collaboration with Dr. Matthew Sturm, a research physical scientist at the Cold Regions Research and Engineering Lab (CRREL) of the U. S. Army Corps of Engineers, Mr. Taras was awarded a start-up grant from the International Arctic Research Center, UAF (IARC) to model Arctic winter ground surface temperatures. Mr. Taras d.b.a. Solid Solutions recently entered into a $21,500 contract with CRREL to continue work with Dr. Matthew Sturm and to coordinate, and participate in, an experiment to ascertain the capability of Ku band radar to "see" snow and changes in snow characteristics during the spring thaw. The project is a collaborative effort with Jet Propulsion Lab (JPL). As a research consultant Mr. Taras also analyzes data collected to evaluate methods used to treat soils contaminated with hazardous chemicals, and he provides assistance in designing such experiments.

As a graduate student of statistics at UAF, Mr. Taras worked as a research assistant for Dr. Brendan P. Kelly applying statistical methods to biological research. He evaluated the nature of autocorrelation in diving data for ringed seals, and analyzed the structure of the dives using regression analysis methods that corrected for the effects of autocorrelation. Mr. Taras analyzed snow/ground interface temperatures, collected in the Kuparuk River basin in northern Alaska, for Dr. Matthew Sturm. For the Alaska Department of Fish and Game, he enhanced a visual basic program to reduce data collected during studies designed to estimate the abundance of fish. While a graduate student, Mr. Taras also worked for the U. S. Geological Survey and was the primary author on a proposal seeking funding to investigate the effects of natural attenuation processes on contaminant concentrations in ground water. The two year, $400,000 proposal was funded by the U. S. Army.

Prior to his decision to return to graduate school in Statistics, Mr. Taras was a Research Physical Scientist for the Cold Regions Research and Engineering Lab (CRREL); U. S. Army Corps of Eng., Fairbanks, AK (1992-1995). He was principal investigator on a project monitoring changing ground-water flow conditions as well as a co-principal investigator on a project analyzing ground-water flow conditions and contaminant transport using Department of Defense's Groundwater Modeling System, a 3 dimensional finite element flow model. From 1984 t0 1992 Mr. Taras worked as an environmental geochemist for the U. S. Environmental Protection Agency. Mr. Taras attained the position of a senior scientist (GM-13) in the Superfund program where he provided technical expertise to project managers in all aspects of the program, served as technical representative in negotiations, advised upper management, and oversaw field activities. Mr. Taras was a member of Region I's Technical Issues Work Group, a multidisciplinary group which developed regional policy on technical issues, and a member of U.S. EPA's Groundwater Forum, a group of senior EPA scientists working closely with the research community to address technical issues confronting environmental restoration.

Publications:

Taras, B., M. Sturm, G. Liston, J. Holmgren, "Modeling Arctic Winter Ground Surface Temperatures", in prep.

Taras, B., M. Sturm, G. Liston, J. Holmgren, 1998: "Predicting Arctic Winter Ground Surface Temperatures using a Statistically based Method", 49th Arctic Science Conference, Fairbanks, AK., October 26-18.

Taras, B., D. Solie, and S. Grant, 1994: "Continuous Monitoring of Changing Ground Water Flow Directions in Areas with Low Gradients to Assist in Contaminant Transport Modeling at Fort Wainwright, AK", EOS.

Taras, B and S. Hart, 1987: "Geochemical Evolution of the New England Seamount Chain: Isotopic and trace element constraints", Chemical Geology, Volume 64, pp. 35-54.

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Selected Reports

Quakenbush, L. T., B. P. Kelly, and B. D. Taras, April 1999: "Topographic Variation in Blubber Thickness among Pacific Walruses, *Odobenus rosmarus*".

Kelly, B. P., L. T. Quakenbush, B. D. Taras, and J. Garlich-Miller, April, 1999: "Age And Sex Composition Of Pacific Walruses In The Chukchi Sea: Research Cruise On The *ARCTIC SUNRISE,* 1-18 September 1998".

Taras, Brian D. and Steven A. Grant, September 29, 1995: "Second Year; Second Interim Report - Continuous Determination of Ground Water Flow Direction and Gradient at Selected Sites of CERCLA Concern, Fort Wainwright", AK, CRREL Contract Report #22.

Taras, Brian D. and Steven A. Grant, June 20, 1995: "Second Year; First Interim Report - Continuous Determination of Ground Water Flow Direction and Gradient at Selected Sites of CERCLA Concern, Fort Wainwright, AK, CRREL" Contract Report #28.

Selected Presentations:

"Pacific Walruses: Population Biology, Trophics, and Use of Sea Ice." Kelly, B. P., L. T. Quakenbush, B. D. Taras, and G. G. Sheffield., accepted for presentation at the Gordon Research Conference on "Controls and Significance of Carbon Fluxes in Polar Seas", Ventura, CA, 7-12 March, 1999.

"Monitoring Changing Ground Water Flow Conditions in Cold Regions; Implications for Site Remediation" at the "Models for Cold-Regions Contaminant Hydrology Workshop", Anch., AK, 8/95.

"Fort Wainwright, Alaska, Ground Water Flow and Contaminant Transport, A Cooperative Effort Involving: USGS, UAF, and CRREL" to the American Society of Civil Engineers, Fairbanks, AK, 5/95.

"Monitoring Changing Ground Water Flow Conditions in Cold Regions", Remediation Technology Update: Petroleum Hydrocarbons, Anchorage, AK, 1/95.

Field Experience:

As a biometrician on a scientific expedition on the Chukchi Sea, Mr. Taras collected sex and age composition data on walrus hauled out on ice floes and advised Dr. Brendan Kelly, chief scientist, on sampling procedures (Sept. 1998). Mr Taras participated in Dr. Kelly's field camps on the ice in Resolute Passage, NWT, Canada (May 1997) and north of Prudhoe Bay (April 1998). In the capacity of a biometrician, he became familiar with data collection procedures and possible sources of uncertainty.

Awards

Special Achievement Award (EPA, 1986-1989 & 1991), NSF Fellowship Honorable Mention (1981), Outstanding Senior Geologist (U. Penn., 1980). Captained MIT rugby and H.S. hockey.

Societies

Member American Statistical Association

References

Dr. Ronald Barry, Associate Professor of Statistics, UAF, (907) 474-7226
Dr. Matthew Sturm, Research Physical Scientist, CRREL, (907) 353-5183
Dr. Brendan Kelly, Professor, UAF Juneau Center, (907) 465-6510

- Preliminary categories for harbor seal markings

Photo ID classification system

NOTE: This classification is intended to narrow the field of possible matches. The intention of this exercise is to choose the "ideal" that most closely resembles your photograph. Pick two selections from each heading. Double circle the selection that you feel most closely represents your photograph.

1. Sex (Presence or absence of penal opening; most easily recorded in the field.)
   a. male
   b. female
   c. unknown

2. Color phase (Kelly, 1981)
   a. light phase: lateral & ventral surfaces are white (to light tan), variable spotted w/ brown to black blotches or spots
   b. dark phase: overall background uniformly dark brown to black over entire body, w/ variable numbers of superimposed light rings
   c. Intermediate I: basically like dark phase, but w/ light rings merging ventrally. Less contrast ventrally between light rings and dark background than the dark phase.
   d. Intermediate II: similar to dark phase having contrasting light rings on a dark background overall, but also having darker spots overall that contrast w/ the background. The background color of Intermediate II seals lighter ventrally than dorsally.

3. Spot to Background Ratio: Represents a ratio of spot cover to background. Measure of how much of a seal's light background is covered w/ spots. Do not take into account the pattern, shape, size, or complexity of spots. Pick the picture that most closely resembles the following categories.

   a. High: Represents a high ratio of spots covering background.
   b. Moderate High
   c. Moderate
   d. Moderate Low
   e. Low: represents a low ratio of spots covering background

4. Spot Complexity: An individual seal may have several spot complexity types. This category refers to the MAJORITY of spots on the seal. This category also refers to the spot size.

    a. Complex large: high degree of merging; larger complex patterns forming w/ very irregular shapes. Majority of spot patterns would come close to completely covering surface area of fore flipper.
    b. Complex small: same general characteristics as complex large, but with smaller spots. Majority of spot patterns would cover approx 50-75% of fore flipper surface area.
    c. Moderate: spots lose round-oval shape and begin to merge; irregular shapes begin to form; simple patterns forming; intermediate to simple and complex. Spot cover approximately less than 40% of fore flipper surface area.
    d. Simple large: Complexity same as simple small, but size of spots larger. Predominantly large spots but may possess some spots of smaller size. Majority of spots diameter at least or larger than the length of the visible claw (on the fore flipper).
    e. Simple small: generally round to oval in shape; smooth; w/ very little to no branching or merging. Predominantly small but may possess some spots of larger size. Majority of spot's diameter would be less than the length of the visible claw (on the fore flipper). When two simple spots are close to each other they are considered simple (for both small and large sizes) if you can discern each spot such as the circles touching in a snowman drawing (see photograph of simple large).

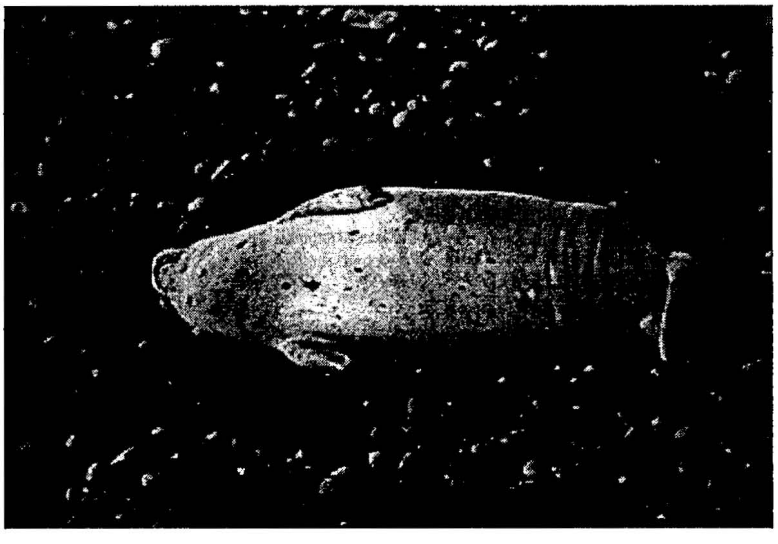
5. Ring Density (applies to dark phase seals)

    a. High: High numbers of rings merging together. Beginning to create the appearance of a light background in some areas of the body. Approaching intermediate 1 color phase, but can still clearly see light rings on a dark background
    b. Moderate High: Rings covering a large proportion of the body; rings appear on all quadrants of the seal
    c. Moderate: Rings beginning to form larger clumps and chains
    d. Moderate Low: Small numbers of rings beginning to merge
    e. Low: very little to no merging of rings. Small numbers of isolated rings on dark background

SEX

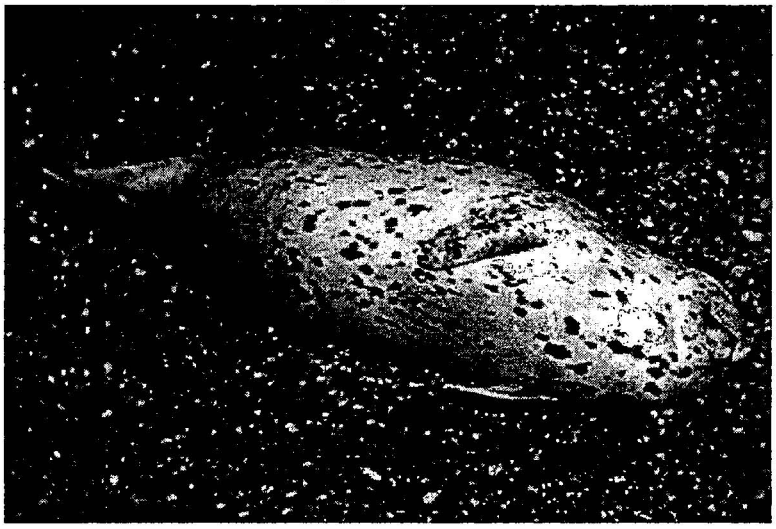
Male

Female

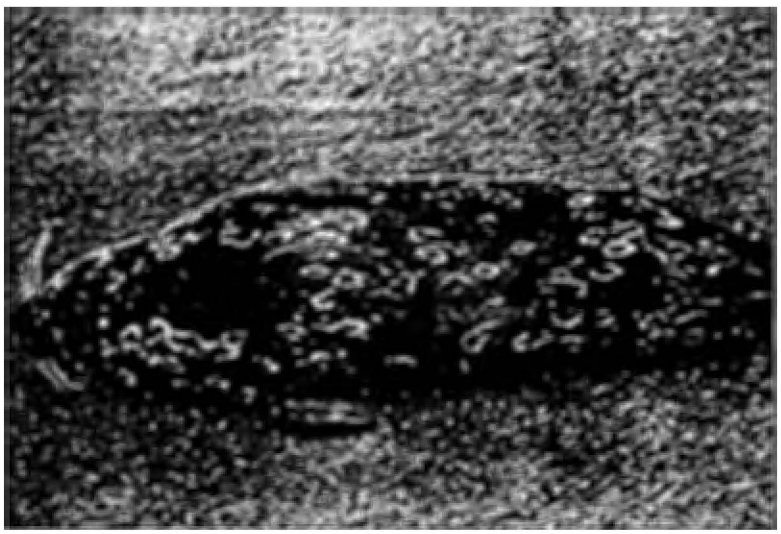


COLOR PHASE

Light Phase

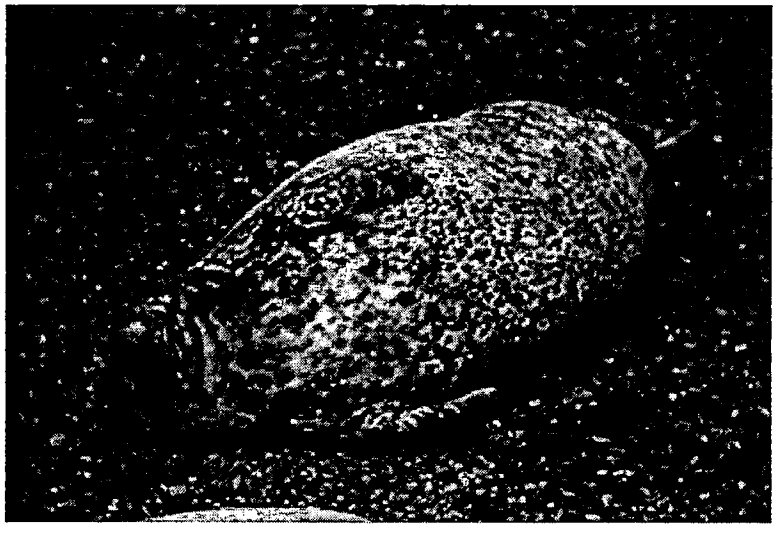


Dark Phase



COLOR PHASE (continued)

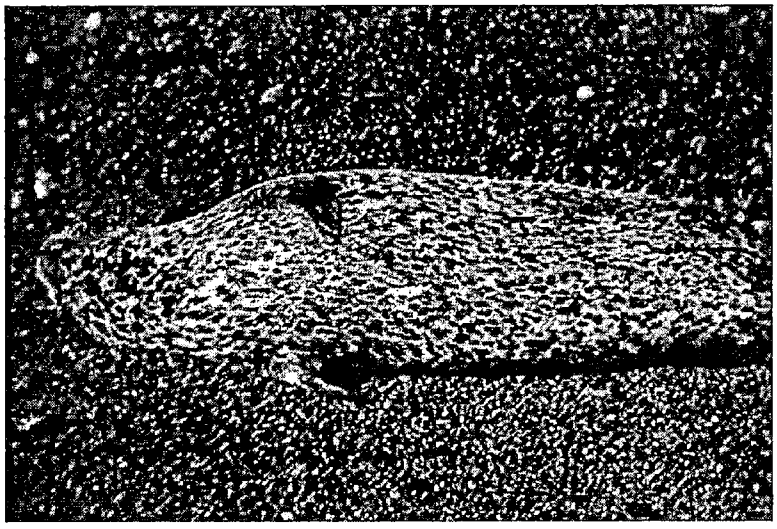
Intermediate 1



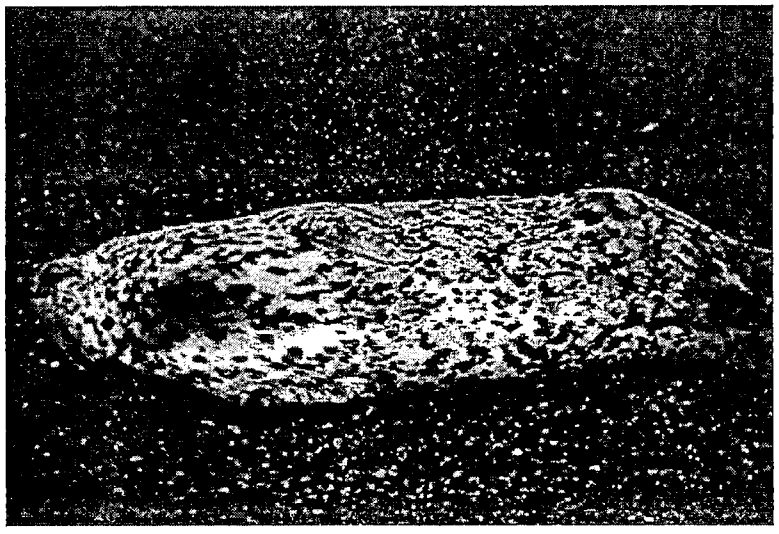
Intermediate 2

SPOT TO BACKGROUND RATIO

High

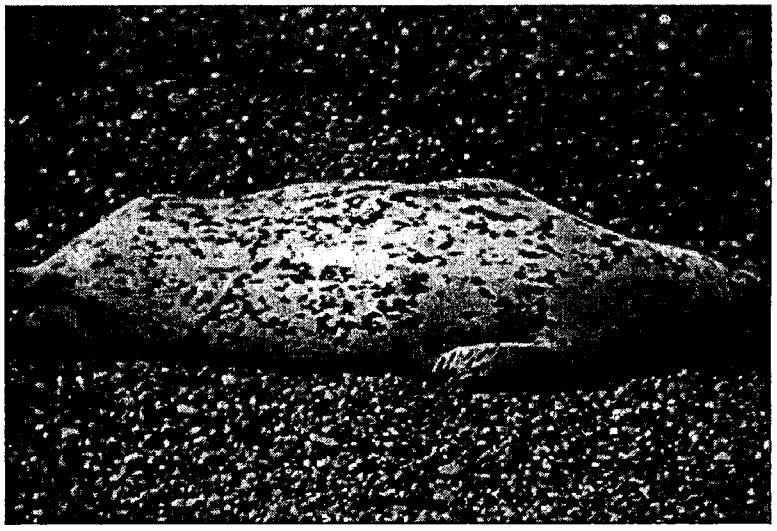


Moderate High

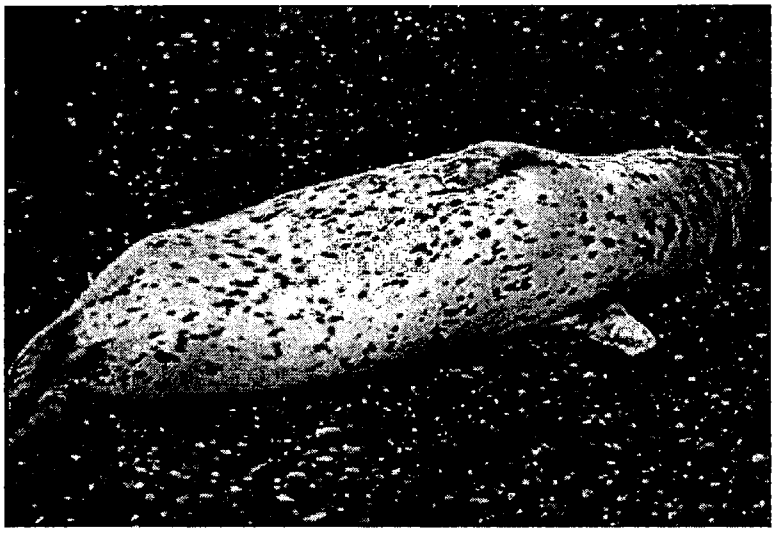


SPOT TO BACKGROUND RATIO (CONTINUED)

Moderate

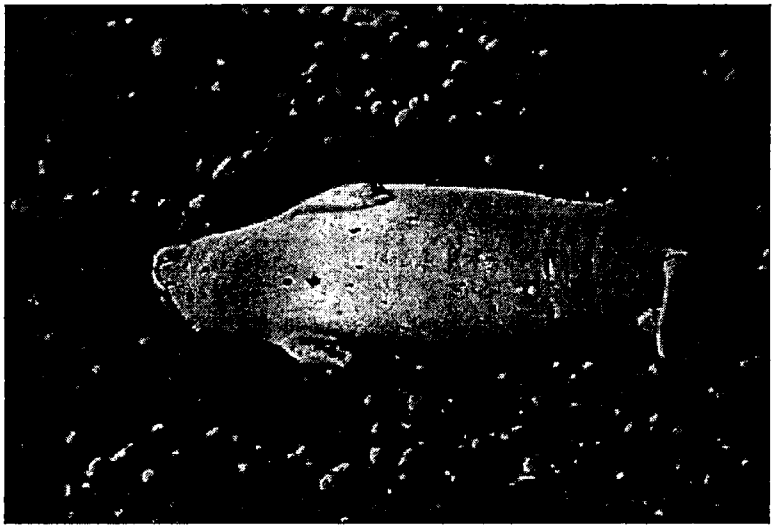


Moderate Low



SPOT TO BACKGROUND RATIO (CONTINUED)

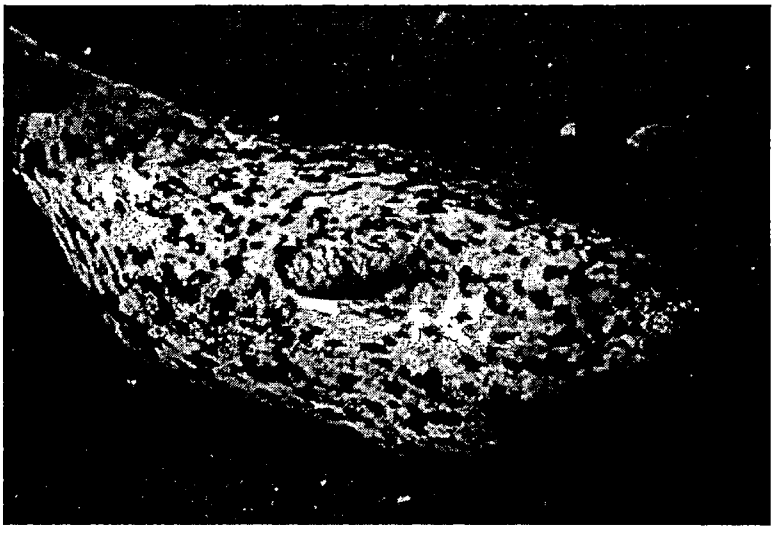
Low



SPOT COMPLEXITY/SIZE

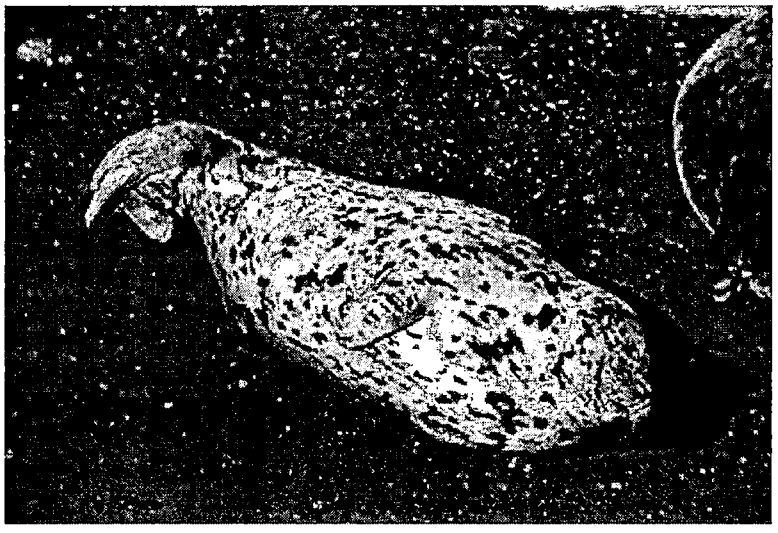
Complex Large

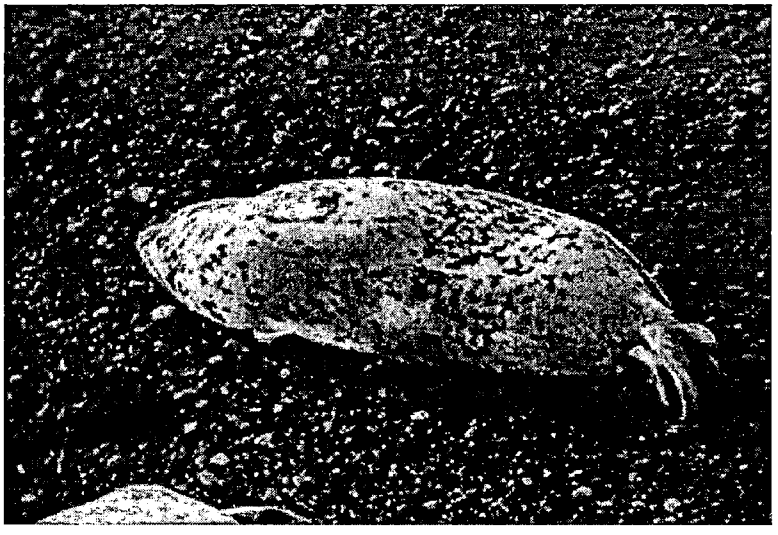
Complex Small



SPOT COMPLEXITY/SIZE (continued)

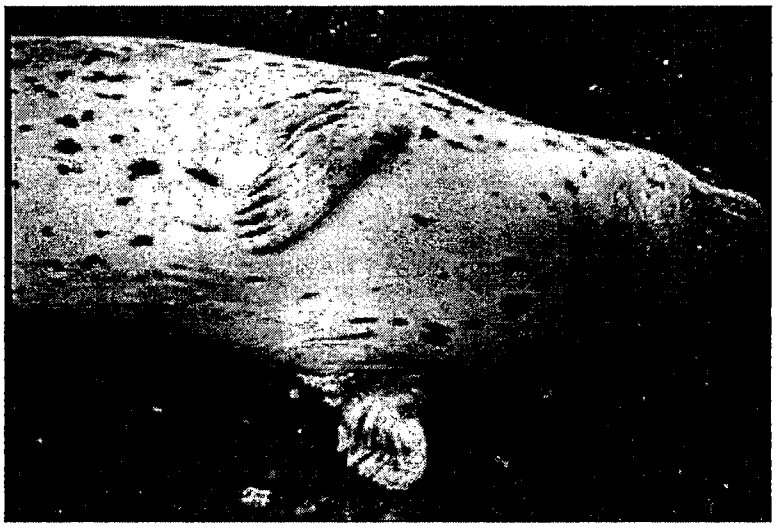
Moderate (2 examples)



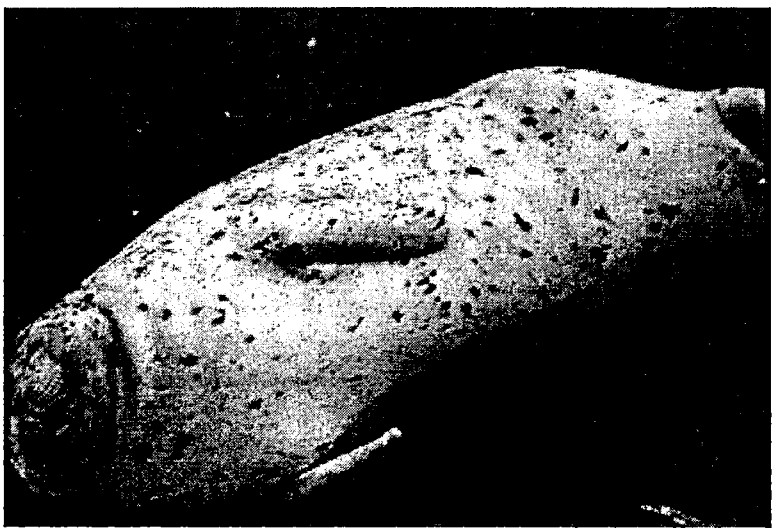


SPOT COMPLEXITY/SIZE (continued)

Simple Large

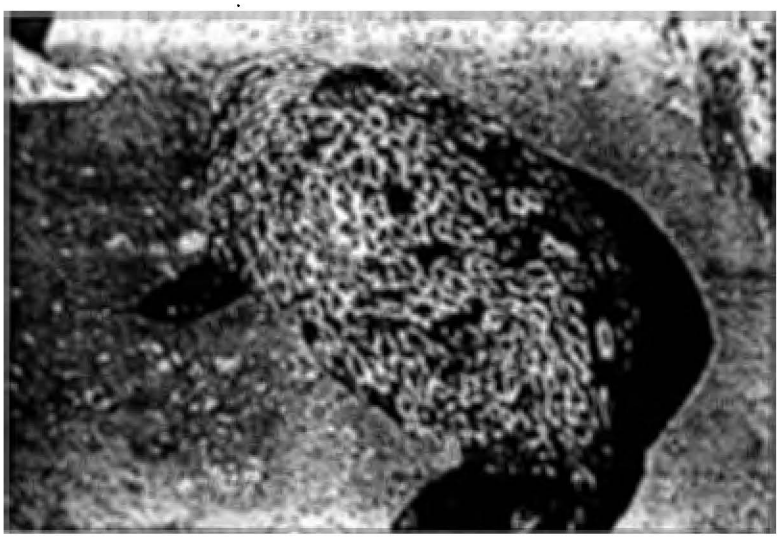


Simple Small



RING DENSITY

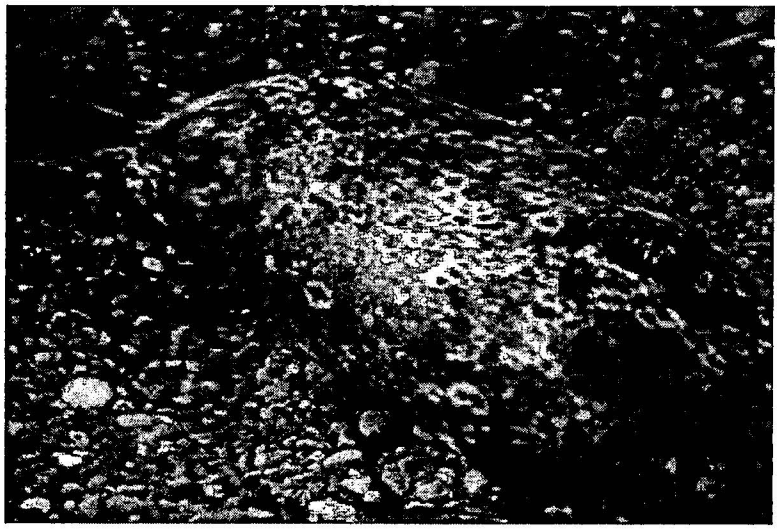
High



Moderate-high

RING DENSITY (continued)

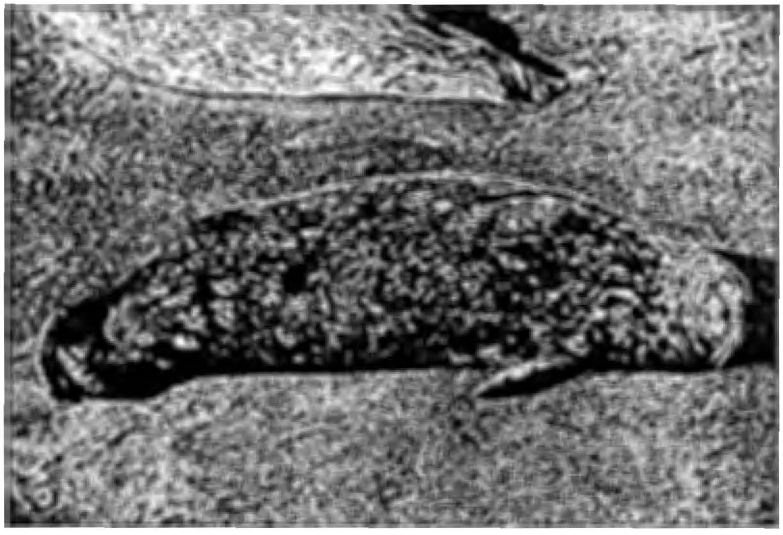
Moderate



Moderate-low

RING DENSITY (continued)

Low



Long-Lived Bioactive Microbial Biooxidation Products From Petroleum

Project Number:	00446
Restoration Category:	Research
Proposer:	University of Alaska Fairbanks
Lead Trustee Agency:	ADFG
Cooperating Agencies:	None
Alaska SeaLife Center:	No
Duration:	Year 1 of 3 Years
Cost FY 00:	$77,373
Cost FY 01:	$70,878
Cost FY 02:	
Geographic Area:	Knight Island, Prince William Sound
Injured Resource:	Breeding pelagic communities in the past, pelagic benthic communities sustaining, including shellfish

ABSTRACT

Toxicity is generated from biochemically inert hydrocarbons by oxidization to long-lived reactive derivatives. Bacteria carry out the oxidation, utilizing small concentrations of dissolved and oil-phase components. Most are excreted following the first oxidation step because of insufficient cytoplasmic enzymes and low amounts of the necessary permeases for active transport. These products, therefore, accumulate in the environment. Unlike hydrocarbons, the products are difficult to extract from seawater, but novel technology allows measurements. The effort is to determine the identity and dynamics of these accumulating components prior to toxicity experiments using defined conditions and compounds.

INTRODUCTION

Measures of the impact of petroleum hydrocarbons on aquatic environments generally rely on the hydrocarbons themselves, usually in the visible oil phase (7), and substantial quantities are required for direct toxicity (21). However, for recently biosynthesized (3 and unpublished) petroleum (8) and anthropogenic hydrocarbons, bioactive components in seawater are thought to be in the dissolved phase (23) and are usually comprised of the products of biological oxidation (13). Ring cleavage products of the oxidation of aromatic hydrocarbons are known to be excreted by marine bacteria (8,10,18) in large quantities, particularly by the dilute-cytoplasm forms that propagate the marine environment (17,20,23). These accumulate due to difficulty bacteria have in actively transporting them, and they substantially exceed concentrations attained by the parent hydrocarbons. We have now observed them in all of numerous laboratory cultures of three isolates, in mutant cultures designed with blocks of further metabolism, and in sustained continuous microbial systems with hydrocarbon input. An understanding of these mechanisms is emerging (11). Because of large attraction to water, they are difficult to remove from water and to identify and quantify. However, new solid-phase microextraction (SFME) techniques have lead to the facile analysis of their concentrations in the environment (in progress). We are now in a position to collect sufficient material from beach water for detailed structural studies as well as making quantitative measurements in seawater.

NEED FOR THE PROJECT

A. Statement of Problem

While dissolved hydrocarbons have a short lifetime, days to months depending on the abundance of appropriate microflora (4), their products of oxidation accumulate and persist (see below). These remain undocumented in studies of Prince William Sound and associated controlled toxicological studies, yet they are likely to be the chief ingredients in long-term affects. Middaugh, et al. (16) found teratogenic responses and mortality from exposure of pacific herring to high dilutions of North Slope crude oil. New technology now makes such an effort feasible. An understanding of spill effects is most efficiently, effectively, and accurately described when the concentrations, dynamics, and biochemical composition of the active components accompany investigation of injured species and their habitat. Of the two philosophies for investigating ecosystem function, holistic and reductive, those in Prince William Sound have primarily been the former. However reductionism is becoming more popular in the biological sciences as technology allows the establishment of cause-effect relationships. Here the effort is to identify chemical compounds that accumulate from oil in the environment so that changes in the function of affected organisms can be related to the causative compounds.

B. Rationale/Link to Restoration

Much of the biodegradation of aromatic hydrocarbons initially proceeds only as far as the first oxidation step and the compounds are expelled from the bacteria. This is because of a dilute cytoplasm designed for operation in the marine environment with little capacity for dealing with concentrations much higher than a few nanograms per liter. The hypothesized route of toluene use and expulsion of oxidized products is shown in Fig. 1 (22). Metabolic systems are induced by interaction of hydrocarbon-induced formation of phosphorylated Tod T that initiates transcription. Metabolism is accelerated by partitioning of the hydrocarbon S into the inner cell membrane. It shows that due to limited enzymatic capacity down stream from the dioxygenase (DO) systems, most of the initial products of oxidation are liberated as products P. The hydrocarbons do not require active transport, and partitioning into the cell membranes increases concentrations for rapid oxidation. When the pathways are overloaded as normally occurs in the case of an oil spill, the products are expelled. Reaccumulation by other organisms is difficult because an expensive active transport mechanism is required that is peculiar to the products liberated. Marine bactria are not equipped to deal with substrate concentrations that are large (6). Since the oxidation of hydrocarbons is relatively non-specific, oxidation occurs through pathways sustained by naturally occurring species, but the products are not normally encountered in the environment, and therefore, few organisms maintain the capacity to use them. Hydrocarbons themselves are biochemically relatively inert at low concentrations, and it is the oxidized forms that are probably responsible for most of the toxicity (12,14).

Established bioreactivity of the water soluble fraction of crude oil, its effect on herring larvae, lack of a known mechanism for the toxicity of dissolved phase hydrocarbons themselves at low concentration, and predicted stability of the products of microbial oxidation of hydrocarbons constitute the reasons for establishing product identification and dynamics as an important step in restoration. That is, know what you are dealing with and understand how it works

C. Location

The problem is general wherever crude oil persists to liberate the products of microbial oxidation. Our sample site is on the south side of Knight Island where crude oil persists in the gravel.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

The main challenge is to transmit highly technical information that we regularly deposit into scientific journals to general media. We have written a number of articles on oil spills and fates that were published in local newspapers, and a number of excerpts have appeared in the national news. Public awareness of trace contaminants is increasing as one sees use of bottled drinking water and concern about the environment in general. But more is required. We have discussed

the problem addressed here for 15 years or so, but there has been insufficient interest to generate a program to address the effort. We stand ready to accept advice on this point.

Our present plan is to present one general educational lecture each year on how marine micro flora affect ocean chemistry. Two such lectures have been presented this year and several more are being scheduled.

PROJECT DESIGN

A. Objectives

1. Scale up successful single fiber microextraction techniques for the isolation of sufficient quantities of the biooxidation products of petroleum oxidation in seawater for chemical identification.

2. Identify the range of products produced by pure cultures from toluene.

3. Quantify and identify the amphipathic compounds in surface groundwater from currently impacted Knight Island beaches.

4. Determine the rate of formation of the identified compounds.

5. Determine the stability of the identified compounds toward complete biodegradation.

6. Determine the toxicity of the identified compounds.

B. Methods

Previous attempts. Biooxidation products of aromatic hydrocarbons were first apparent to us by the appearance of a bright yellow color in the culture media of bacterial isolates from Prince William Sound when incubated with toluene. When applied to mixed cultures associated with hydrocarbon biodegradation, the cultures turned yellow as well. Application of radioactive hydrocarbons to both isolates and to mixed cultures resulted in the conversion of most of the hydrocarbon to non-volatile components (8). These had the spectrum of 2-hydroxy oxoheptadienoic acid (HODA) and appeared in thin layer chromatograms at locations consistent with HODA, toluene dihydrodiol, *o*-cresol and 3-methyl catechol (18).

One method of analysis is to derivatize active groups formed during conversion, extract them with solvent, and analyze by GC/MS (gas chromatography/mass spectroscopy) to identify the compounds. Pure cultures produced new compounds compared to the controls, but the method

was not very satisfactory in our hands due to low sensitivity and interference with degradation products of the reagents. Some workers used superior derivatizing agents but concerns about health hazards from these exceedingly reactive reagents precluded their use here.

Another method sometimes used for the identification of metabolic products from the biodegradation of aromatic hydrocarbons is thermospray HPLC-MS (15). We attempted analysis by this method in the laboratory of Fritz Jüttner in Switzerland, but the effort was unsuccessful.

Successful separations. A new method for the analysis of hydrocarbons at small concentrations is single fiber microextraction (9), and it appears to be suitable for the analysis of semipolar compounds of the type in question as well. We predicted from kinetic data on hydrocarbon metabolism that monoterpene hydrocarbons would appear in seawater (2), a prediction that led to their discovery (3). Another related prediction led to a search for terpene (C_{10}) oxidation products. Compounds consistent with that prediction appeared in most of 50 samples collected in Alaskan streams and estuaries. As shown in Fig. 2, the method consistently resolved a group of compounds that appears in rivers along the Kenai and in the Gulf of Alaska near Homer. The normal 3-ml samples were sufficient to reproducibly resolve five compounds. Mass spectrometric analysis showed them to be near C_{10} in size, non-aromatic, and containing a single oxygen, but the amount of material collected from 3-ml seawater samples is insufficient for structural analysis. Whether concentrations of amphipathic compounds derived from hydrocarbons in pits dug in the sands of impacted beaches is sufficient for quantitative analysis by this technique is unknown but the prospect is likely. In any case larger quantities are useful for more precise chemical identification.

Another new procedure for identification of the products of hydrocarbon oxidation by mixed cultures uses nuclear magnetic resonance studies of ^{13}C-labeled compounds (22) and the products of hydrocarbon degradation in mixed microbial mixtures have been successfully identified in this way. The appropriate equipment is present in one of the PI's departments, and the PI has been in regular communication with the originator of this method.

Scale up. The proposed procedure to obtain the mg-quantities of the biooxidation products necessary for convenient identification is as follows: Water is collected, debris is gently filtered off with a commercial coffee filter as recommended by the manufacturer, and an internal standard added on site. Most bacteria remain with the sample but these should pass through the large porosity column as well since the oxygenated hydrocarbons are absorbed into the solid phase from the flow steam. The solid phase is comprised of a C_{18} reverse-phase sorbant bonded silica on glass fiber (Supelco) discs. These have a large seawater capacity of 100 ml per minute. The disks are extracted with acetonitrile and then methylene chloride for return to the laboratory. The extracts are combined dried over sodium sulfate and frozen until analysis. A liter or less of water from the pits should be sufficient for analysis, whereas, at least 100 liters of water is required for the surrounding seawater. Blanks of deionized water are treated in the same manner.

Triplicate estuarine SFME samples frozen in dry ice and returned to Fairbanks for analysis are mostly quite reproducible, but sometimes, the compounds are lost and unfrozen samples and even ones frozen at moderate temperatures can degrade probably due to residual bacterial activity. Hopefully the sample extracts will be stable, but some will be stored at room temperature for short periods before analysis to verify that losses are minimal. We are well acquainted with the Knight Island site, its access by floatplane, and the location of remaining hydrocarbon residues as a result of an Alaska Science and Technology-funded bioremediation project there.

Standards with a range of functional groups such as alkanes, alcohol, aromatics are prepared in seawater to determine extraction efficiencies and capacity of disks to absorb organic compounds. The procedure is repeated with in 0.02 μm polycarbonate filtered seawater to determine if the 1-3 million/ml bacterial populations contribute compounds to the column.

Analysis is conducted on samples following evaporation down to one milliliter. The compounds of interest are separated by GC analysis (Hewlett-Packard 5980, flame ionization detector) to locate peaks of interest.

Identification. Compounds are characterized by GC-MS analysis (Hewlett-Packard 5972) and comparison of fragmentation patterns with those provided with the associated library or by consulting other libraries where necessary. Additional information regarding structural details of the peaks of interest may be required. This is provided by construction of trymethylsilyl derivatives. Preliminary results show that procedures were successful at 200 μg/ml concentrations of ketohexanoic, muconic and toluic acids and other expected compounds. Backup methods include the C-13 procedure conducted either here or at Gulf Breeze, Florida, with the originator of the method.

Quantitation. Concentrations are measured by proven SFME techniques in seepage water from Knight Island. For surrounding seawater, concentrations are measured following Scale-up of the procedure to evaluate 100-liter quantities. Concentrations are made by comparison with internal standards.

Formation rate. Rates of formation of the oxidized products are determined by short-term (minutes) incubations with trace quantities of added radioactive hydrocarbon using techniques common to this laboratory (8,18). Radioactivity remaining in the filtrate of an acidified fraction gives convenient indication of the rate of product formation. Material balances that give the amount of hydrocarbon going to cell material and carbon dioxide typically account for the hydrocarbon added with a smooth progression over time and are unnecessary in the field at this point. Rates are reported as a function of hydrocarbon concentration and bacterial biomass. The bacterial biomass is determined by novel accurate flow cytometric techniques developed in this laboratory (5,19,20). Rate is related to hydrocarbon concentration as well, and the two are

combined in the novel specific affinity theory also developed in this laboratory for that purpose (1,8). The theory accounts for organism cytoarchitecture and dioxygenase content as well as biomass, hydrocarbon concentration, shifting points of limitation as hydrocarbon concentration change, and the rather curious liberation of metabolic products that accompanies the biodegradation of hydrocarbons.

Persistence. Radioactive products are formed from all the hydrocarbon oxidizing isolates we have on hand. These can be used to determine the stability of the oxidation products in the environment.

Pseudomonas putida forms the products in small quantity but a mutant strain that we have, 39D, produces large quantities of toluene dihydrodiol according to GC-MA analysis. Recent GC traces show large amounts of other components appearing as well, possibly including ortho cresol. Both the recently described novel Prince William Sound bacterial isolates *Marinobacter arcticus* (18) and *Cycloclasticus oligotrophus* convert about 60% of metabolized toluene to oxidized products (Fig. 3). A trace from *Marinobacter arcticus* with a peak consistent with the formation of HODA is shown in Fig. 4; the other peak is an artifact present in the blank. Product formation is thought to be due to limited amounts of enzymes down stream from toluene dioxygenase. Thus, the fast growing *P. putida* produces little product due to ability to function at large concentrations of hydrocarbon, but the two marine isolates, known to be comparatively low in cytoplasmic enzymes (8) produce them in copious quantities.

Radioactive products are produced from ^{14}C-toluene, the cells filtered off, the toluene removed by evaporation, the remaining products characterized by SFME GC-MS, and the compounds used to charge fresh samples from Knight Island beach ground water. Stability is calculated from their specific affinity towards the culture. This measure is a novel unambiguous way of characterizing the stability of a microbial culture/substrate mixture as discussed above. Values for toluene can approach several thousand liters/g-cells hour, but a compound that is stable in the environment may have values less than unity (1) giving lifetimes of decades. Residence time is given by $(a_S\ X)^{-1}$ where a_S is specific affinity and X is bacterial biomass as determined by flow cytometry.

Toxicity. Toxicity is determined by conventional methods but using known concentrations of known products of biooxidation products as determined and monitored above. This phase begins in year three with procedures to be developed based on findings here to be proposed near the end of the first two years.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

None

SCHEDULE

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

FY 00

September:	Begin scale up work of SFME using pure cultures.
October:	Complete manuscript in preparation on the theory and preliminary results outlining the forces leading to the formation and persistence of organic products from the oxidation of aromatic hydrocarbons in the marine environment.
January:	Report recoveries of organic products produced from pure cultures known to liberate major quantities of these products from aromatic hydrocarbons as indicated by quantitative GC by comparison with standards along with any modifications required such as changes in conditions and solvent extraction mixtures.
April:	Report on the general kinetics of aromatic hydrocarbon bioconversion at the national meeting of the American Society for Microbiology. Submit report to Trustee Council.
June:	Report the chemical nature of the products produced by pure cultures from the biodegradation of toluene.
July:	Conduct sampling on Knight Island *in situ* incubations to determine rates of product formation.
September:	Report the concentrations of amphipathic compounds in Knight Island ground water likely to derive from remnants of the *Exxon Valdez* oil spill.

FY 01

April:	Report results at one national meeting. Submit annual report to Trustee Council.
July:	Conduct *in situ* incubations with radioactive organic products produced.
September:	Report the expected lifetimes of these products in the environment based on decay rates of isotopic additions together with the biomass of associated bacteria with a complete compilation of results in a manuscript for a refereed journal.

B. Project Milestones and Endpoints

The major milestones are 1) location of expected products of hydrocarbon oxidation products in beach water, 2) location in seawater, 3) identification, 4) determination of production and decay rates, and 5) understanding their toxicology. We expect completion of points 1 and 2 in year one and progress on points 3 and 4 during the second year. Based on experience, structural

should be able to identify some, and difficulties with the rate studies are not expected. The toxicological investigations 5) will be planned with different personnel following experiences with the first two years effort.

C. Completion Date

Determination of oxidized product dynamics is expected in September of 2001 with toxicity investigations to be considered at that time. In our laboratory about a year is required to consider accumulated data and assemble that data into manuscripts.

PUBLICATIONS AND REPORTS

Button, D. K. Properties of small free-living aquatic bacteria. The size limits of very small organisms: Proceedings of a workshop: Steering Group on Astrobiology of the Space Studies Board, National Research council, 1998.

Robertson, B. R., and **D. K. Button.** 1999. Bacterial biomass from measurements of forward light scatter intensity by flow cytometry. *In* P. Robinson (ed.), Current Protocols in Cytometry. John Wiley & Sons, New York.

Button, D. K., and B. R. Robertson. In progress. Distributions of bacterial biomass in aquatic systems.

Button, D. K., and B. R. Robertson. In progress. Marine bacterial activity, productivity, and viability; toward establishing accurate values.

Button, D. K., and B. R. Robertson. In progress. Seasonal shifts in bacterial size, DNA content and activity in a subarctic lake.

Button, D. K., and B. R. Robertson. In progress. Space requirements and kinetic theory anticipate nanoplankton size and cytoarchitecture.

Craig, K. S., and **D. K. Button.** In progress. A high-affinity peremeaseless hydrocarbon transport mechanism and the reason for oxidation product accumulation in seawater.

Button, D. K., and B. R. Robertson. In progress. The distribution of DNA among bacterioplankton and among *Cycloclasticus oligotrophus* cells growing at various rates by flow cytometry of DAPI-stained organisms.

PROFESSIONAL CONFERENCES

As a member of four related scientific societies, several papers are normally presented each year.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Preliminary work has been funded by the Office of Exploratory Research, U.S. Environmental Protection Agency. We have a small ongoing project with the Natural Resources Fund at the University that looks at the formation of oxidized products from terpene hydrocarbons liberated by Spruce Bark Beetles from spruce trees in Prince William Sound. A program from the National Science Foundation Life in Extreme Environments initiative examines the basic properties and kinetics of typical aquatic bacteria including at least one isolate typical of Prince William Sound and having a tendency to produce large amounts of the contaminants in question. That agency helps support much of the very expensive microbiological equipment to be used here.

PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

Don K. Button

Professor, Institute of Marine Science, 1964–present; Biochemistry/Molecular Biology Program, Department of Chemistry and Biochemistry, 1988–present, University of Alaska Fairbanks.
Visiting Professor, University of Notre Dame, Department of Chemistry, 1976.
Research Associate, University of Colorado, Department of Biophysics, 1970.

Professional Memberships: American Association for Biochemistry and Molecular Biology, International Society for Analytical Cytology, American Chemical Society, American Society for Microbiology, American Society for Limnology and Oceanography, American Association for the Advancement of Science, Sigma Xi, and Society of Physical Optical Engineers.

Panels and Boards: National Academy of Sciences panel of hydrocarbons in the environment; National Research Council panel on size limits of very small organisms; and Technical Advisory Board for the elimination of toxic wastes from oil tanker ballast water. National Academy of Sciences Space Studies Board workshop on size limits for microorganisms.

Distinguished Service Award: a member of the editorial board for Applied and Environmental Microbiology.

Selected Publications:

Button, D. K. 1998. Nutrient uptake by microorganisms according to kinetic parameters from theory as related to cytoarchitecture. Microbiol. Mol. Biol. Rev. **62**:636-645.

Button, D. K., B. R. Robertson, T. Schmidt, and P. Lepp. 1998. A small, dilute-cytoplasm, high-affinity, novel bacterium isolated by extinction culture that has kinetic constants compatible with growth at measured concentrations of dissolved nutrients in seawater. Appl. Environ. Microbiol. **64**:4467-4476.

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27:49-61

Wang, Y., P. C. K. Lau, and **D. K. Button.** 1996. A marine oligobacterium harboring genes known to be part of aromatic hydrocarbon degradation pathways of soil pseudomonads. Appl. Environ. Microbiol. **62**:2169-2173.

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Button, D. K., F. Schut, P. Quang, R. M. Martin, and B. Robertson. 1993. Viability and isolation of typical marine oligobacteria by dilution culture: Theory, procedures and initial results. Appl. Environ. Microbiol. **59**:881-891.

Schut, F., E. DeVries, J. C. Gottschal, B. R. Robertson, W. Harder, R. A. Prins, and **D. K. Button.** 1993. Isolation of typical marine bacteria by dilution culture: Growth, maintenance, and characteristics of isolates under laboratory conditions. Appl. Environ. Microbiol. **59**:2150-2160.

Button, D. K., B. R. Robertson, D. McIntosh, and F. Jüttner. 1992. Interactions between marine bacteria and dissolved-phase and beached hydrocarbons after the *Exxon Valdez* oil spill. Appl. Environ. Microbiol. **58**:243-251.

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Button, D. K., and B. R. Robertson. 1989. High resolution flow cytometry as an analytical tool for aquatic bacteria, p. 180-185. *In* G. C. Salzman (ed.), Proceedings: New technologies in cytometry, vol 1063. Int. Soc. Optical Eng., Los Angeles.

Button, D. K., and B. R. Robertson. 1989. Kinetics of bacterial processes in natural aquatic systems based on biomass as determined by high-resolution flow cytometry. Cytometry **10**:558-563.

Robertson, B. R., and D. K. Button. 1989. Characterizing aquatic bacteria according to population, cell size and apparent DNA content by flow cytometry. Cytometry **10**:70-76.

Robertson, B. R., and D. K. Button. 1987. Toluene induction and uptake kinetics and their inclusion in the specific-affinity relationship for describing rates of hydrocarbon metabolism. Appl. Environ. Microbiol. **53**:2193-2205.

Button, D. K. 1986. Affinity of organisms for substrate. Limnol. Oceanogr. **31**:453-456.

OTHER KEY PERSONNEL

Douglas McIntosh: Analytical measurements of the products of microbial hydrocarbon oxidation. Flow cytometer operator: TBN. Microbiological measurements and field studies.

LITERATURE CITED

1. **Button, D. K.** 1998. Nutrient uptake by microorganisms according to kinetic parameters from theory as related to cytoarchitecture. Microbiol. Mol. Biol. Rev. **62**:636-645.

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9. **Eisert, R., and J. Pawliszyn.** 1997. New trends in solid-phase microextraction. Environ. Toxicol. Water Qual. **27**:103-135.

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Microbiol. **58**:496-501.

11. **Healey, F. P.** 1973. Characteristics of phosphorus deficiency in *Anabaena*. J. Phycol. **9**:383-384.

12. **Hoppe, H.-G.** 1977. Analysis of actively metabolizing bacterial populations with the autoradiographic method, p. 179-197. *In* G. Rheinheimer (ed.), Microbial ecology of a brackish environment. Ecological studies, vol 25. Springer-Verlag, New York.

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14. **Li, S., and L. P. Wackett.** 1992. Trichloroethylene oxidation by toluene dioxygenase. Biochem. Biophys. Res. Commun. **185**:443-451.

15. **Locher, H. H., C. Malli, S. W. Hooper, T. Vorherr, T. Leisinger, and A. M. Cook.** 1991. Degradation of *p*-toluic acid *p*-tolunecaroxylic acid and *p*-toluenesulphonic acid via oxygenation of the methyl sidechain is initiated by the same set of enzymes in *Cmamonas testosteroni* T-2. Appl. Environ. Microbiol. **137**:2201-2208.

16. **Middaugh, D. P., M. E. Shelton, C. L. McKenney, G. Cherr, P. Chapman, and L. A. Courtney.** 1998. Preliminary observations on responses of embryonic and larval pacific hering, *Clupea pallasi*, to nutral fraction biodegradation products of weathered Alaska North Slope oil. Arch. Environ. Contam. Toxicol. **34**:188-196.

17. **Powers, D. A.** 1989. Fish as model systems. Science **246**:352-358.

18. **Robertson, B. R., and D. K. Button.** 1987. Toluene induction and uptake kinetics and their inclusion in the specific-affinity relationship for describing rates of hydrocarbon metabolism. Appl. Environ. Microbiol. **53**:2193-2205.

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using giloma cells contained in sealed rolling bottles, with controlled vapor concentration. Toxic. *in Vitrio* **8**:605-607.

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23. **Shelton, M., P. J. Chapman, S. Foss, and W. Fisher.** Formation of degradation products by marine microorganisms: composition and toxicity.

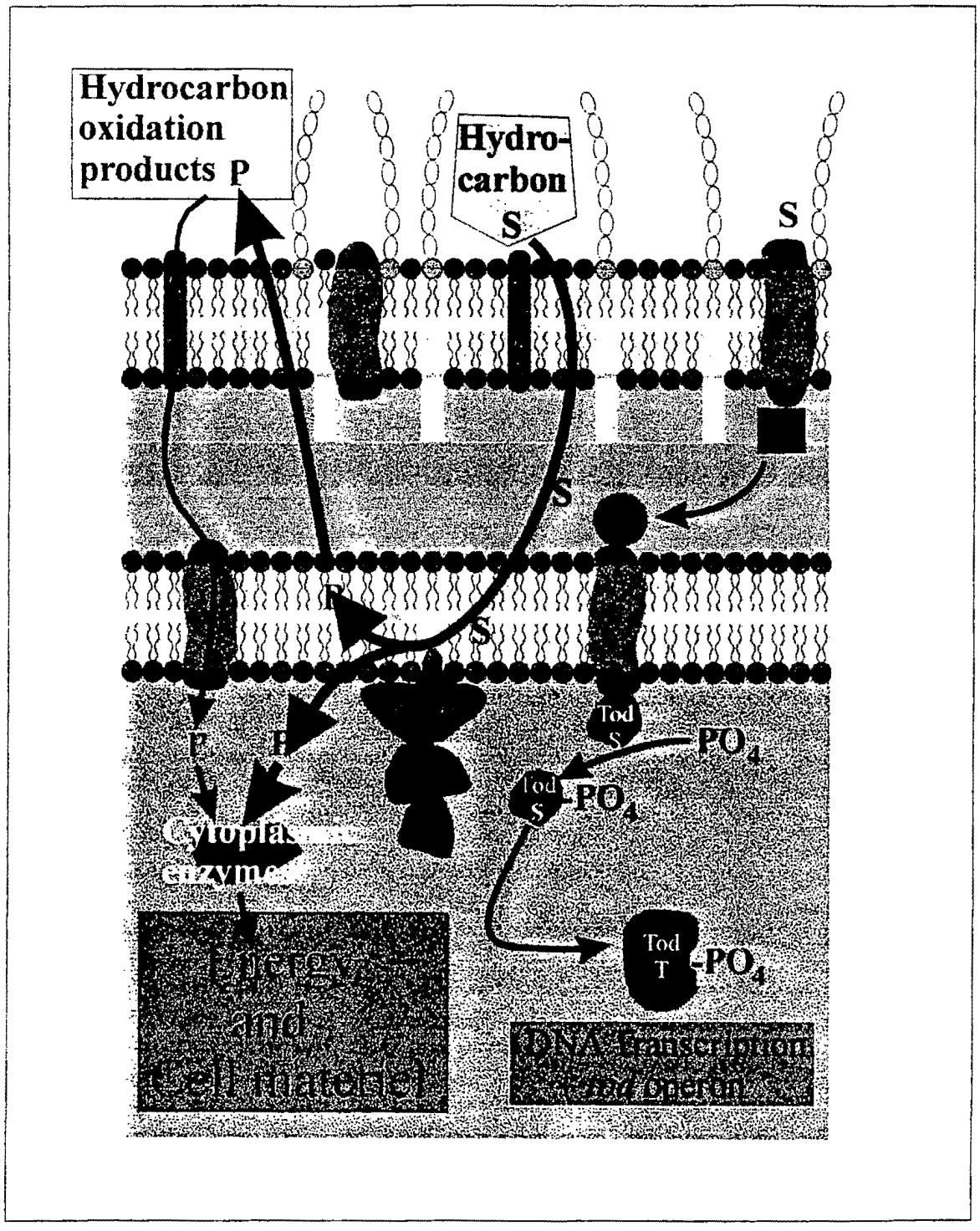


Fig. 1. Excretion of metabolic products from hydrocarbons by marine bacteria. Hydrocarbons are sensed in the outer membrane by the Tod system at right. Dioxygenases DO are formed but are only sufficient for metabolizing typical ambient concentrations of various hydrocarbons in seawater. Cytoplasmic enzymes down stream are insufficient for the metabolism petroleum hydrocarbons and most are liberated as oxidized metabolic products (top left)

Oxygenated Hydrocarbons in Seawater

GC traces from river-water samples

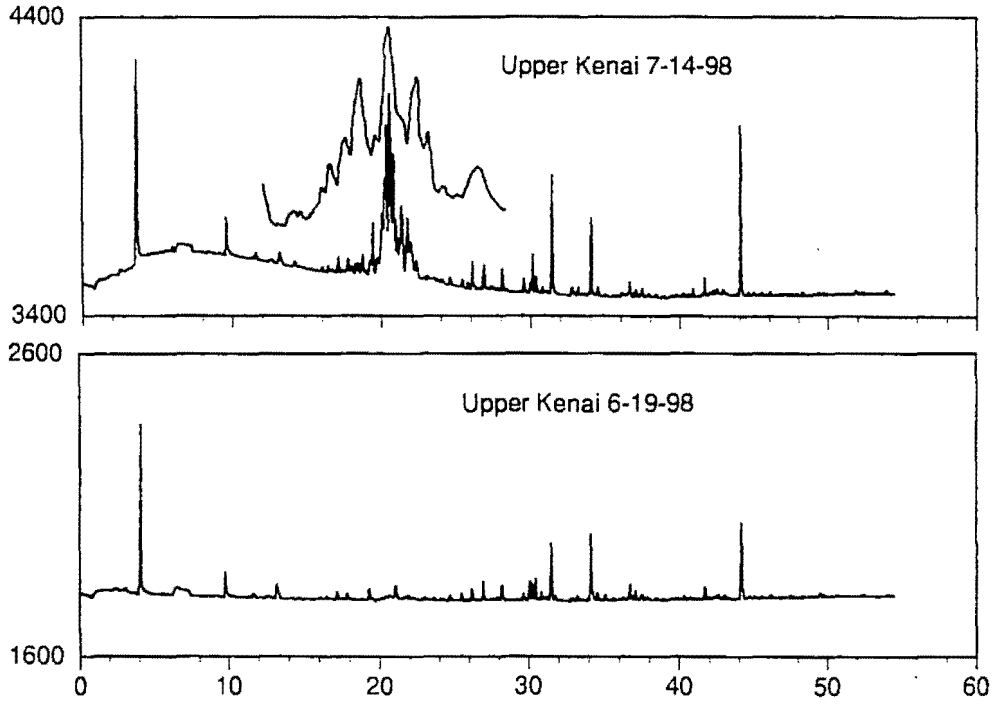
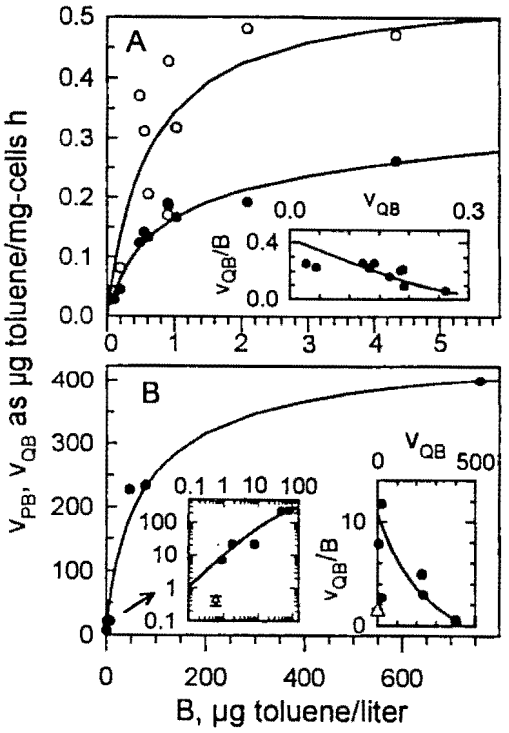


Fig. 2. Resolution of naturally occurring terpene hydrocarbons entering Cook Inlet that were resolved by SFME.



Toluene (substrate *B*) uptake kinetics. (A) Uptake over 4 min with 2,590 µg of cells/liter; (B) uptake over 90 min with 2.4 µg of cells/liter. [^{14}C]toluene uptake was from the rate of liberation of oxidation products (V_{PB}) (○) and CO_2 (V_{QB}) (●) and was calculated as toluene mass; toluene uptake rates from CO_2 recovered from continuously grown cells (△) are also shown (31). Rates were calculated from the appearance of cell material, CO_2, and metabolic products.

Fig. 3. Conversion of toluene to oxidized excretion products by *Cycloclasticus oligotrophus*, a typical marine oligobacterium isolated from Prince William Sound. From Button et al., 1998.

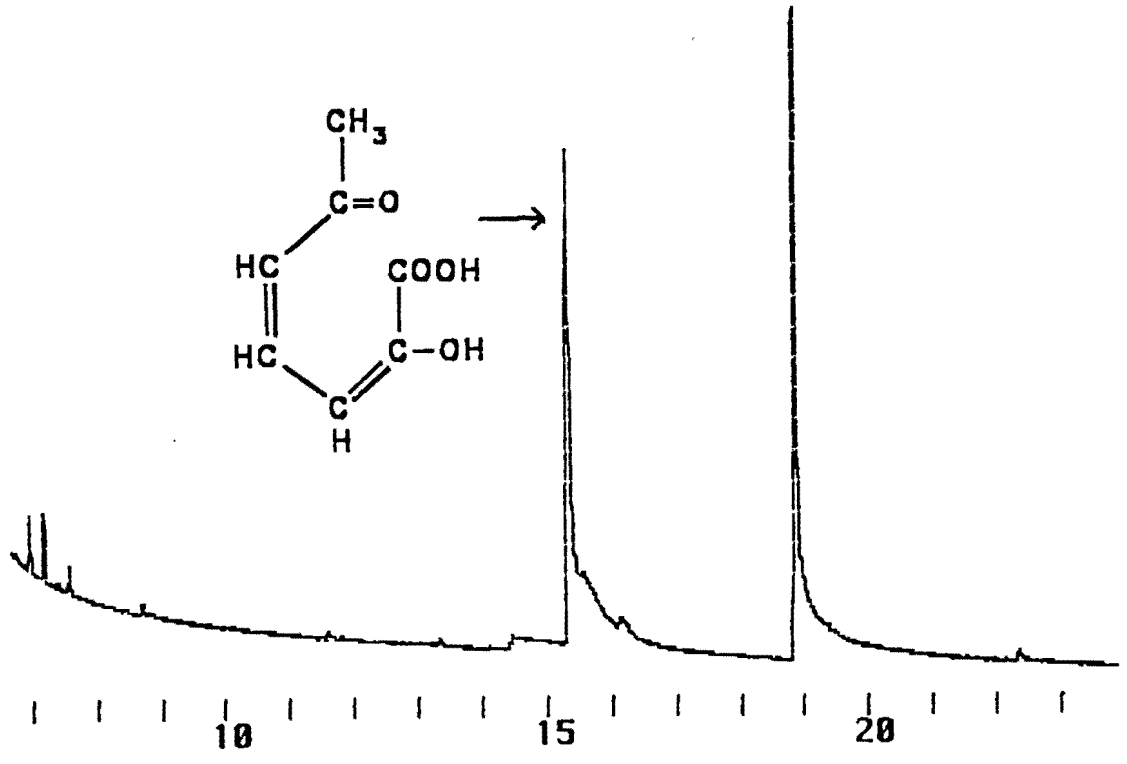


Fig. 4. Separation of excretion products from the metabolism of toluene by *Marinobacter arcticus* isolated from the ballast water of the oil tanker *Exxon Valdez.*

PRINCIPAL INVESTIGATOR

Don K. Button

Professor, Institute of Marine Science, 1964–present; Biochemistry/Molecular Biology Program, Department of Chemistry and Biochemistry, 1988–present, University of Alaska Fairbanks.
Visiting Professor, University of Notre Dame, Department of Chemistry, 1976.
Research Associate, University of Colorado, Department of Biophysics, 1970.

Professional Memberships: American Association for Biochemistry and Molecular Biology, International Society for Analytical Cytology, American Chemical Society, American Society for Microbiology, American Society for Limnology and Oceanography, American Association for the Advancement of Science, Sigma Xi, and Society of Physical Optical Engineers.

Panels and Boards: National Academy of Sciences panel of hydrocarbons in the environment; National Research Council panel on size limits of very small organisms; and Technical Advisory Board for the elimination of toxic wastes from oil tanker ballast water. National Academy of Sciences Space Studies Board workshop on size limits for microorganisms.

Distinguished Service Award: a member of the editorial board for Applied and Environmental Microbiology.

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Douglas McIntosh: Analytical measurements of the products of microbial hydrocarbon oxidation. Flow cytometer operator: TBN. Microbiological measurements and field studies.

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2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$0.0
Travel		$0.0
Contractual		$77.4
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$77.4
General Administration		$5.4
Project Total	$0.0	$82.8
Full-time Equivalents (FTE)		0.3
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		

Dollar amounts are shown in thousands of dollars.

Comments:

FY00

Prepared:

Project Number: 00446
Project Title: Long-Lived Bioactive Biooxidation Products From Petroleum
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRUS[illegible] COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$36.1
Travel		$3.2
Contractual		$9.6
Commodities		$5.0
Equipment		$10.0
Subtotal	$0.0	$63.9
Indirect		$13.5
Project Total	$0.0	$77.4
Full-time Equivalents (FTE)		0.3
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		$70.9			

Dollar amounts are shown in thousands of dollars.

Comments:

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

FY00

Prepared:

Project Number: 00446
Project Title: Long-Lived Bioactive Biooxidation Products From Petroleum
Name: Don K. Button

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
	Don K. Button	Principal Investigator/Professor	2.0	11.9		23.8
	Douglas McIntosh	Research Associate	2.0	6.1		12.3
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	4.0	18.0	0.0	
					Personnel Total	$36.1

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2000
	Fairbanks to national meeting	0.8	1	6	2.0	1.7
	Fairbanks to Kenai	0.3	4			1.2
	Fairbanks to public lectures	0.3	1			0.3
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$3.2

FY00

Prepared:

Project Number: 00446
Project Title: Long-Lived Bioactive Biooxidation Products From Petroleum
Name: Don K. Button

FORM 4B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
Service contract for analytical equipment	7.0
Float plane	1.6
Publication page charges	1.0
Contractual Total	$9.6

Commodities Costs:	Proposed
Description	FY 2000
Isotopes	1.5
Columns and solvents	2.0
Chemicals and glassware	1.5
Commodities Total	$5.0

FY00

Prepared:

Project Number: 00446
Project Title: Long-Lived Bioactive Biooxidation Products From Petroleum
Name: Don K. Button

FORM 4B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2000
Description			
Ultracentrifuge swinging bucket rotor			10.0
			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**	$10.0

Existing Equipment Usage:	Number of Units	
Description		

FY00

Project Number: 00446
Project Title: Long-Lived Bioactive Biooxidation Products From Petroleum
Name: Don K. Button

FORM 4B
Equipment
DETAIL

Prepared:

Project Title: Information Gateway to Prince William Sound and the Gulf of Alaska

Project Number:	00447
Restoration Category:	Research: Information Management
Proposer:	Mark Shasby and William Seitz
Lead Trustee Agency:	U.S. Geological Survey, DOI
Cooperating Agencies:	
Alaska SeaLife Center:	No
Project Duration:	Multi-year
Cost FY 00:	$ 50,400
Cost FY 01:	$200,000
Cost FY 02:	$200,000
Geographic Area:	No fieldwork planned
Injured Resource/Service:	

ABSTRACT

This project will provide for the inclusion of all relevant environmental and spatial data bases developed from the Exxon Valdez Oil Spill Restoration program into a technologically advanced INFORMATION GATEWAY TO PRINCE WILLIAM SOUND AND GULF OF ALASKA. This activity would occur as one of the national prototype areas for a new Gateway to the Earth initiative within the U.S. Geological Survey (USGS). The Gateway targets the World-Wide Web for presentation of this proposed information system. All federal agencies are committed to the development of the National Information Infrastucture **(NII)**, computers and telecommunication networks, services and applications. The USGS is the lead federal agency for the development and management of two primary components of the NII, the National Spatial Data Infrastructure **(NSDI)** and the National Biological Information Infrastructure **(NBII)**. The USGS is combining these two major national programs under a new initiative known as "**GATEWAY TO THE EARTH**" which embodies data management, archiving, access, and decision support analysis tools for use by the entire information community. This proposal will insure a long term commitment to the inclusion of the EVOS data bases into the NII Framework and the next generation of information superhighway technologies that will be evolving.

INTRODUCTION

Now is the time for preparing to manage, archive, and create accessibility to the enormous wealth of EVOS-funded research data and information; the current Restoration program is near closure, and preparation for the design of a research and long-term monitoring program for the Restoration Reserve is beginning. The USGS, working closely with federal and state partners such as the Alaska Department of Natural Resources (ADNR), proposes to link the ultimate management of *Exxon Valdez* oil spill (EVOS) information with a new national initiative: **Gateway to the Earth**. Leveraging of funding and efforts from the Trustee Council with national funds competitively available to the USGS for prototype projects under the Gateway Initiative will allow for the early development of a truly advanced and comprehensive information system in support of EVOS Trustee objectives. This project will also ensure that the Trustee Council's past and future investments in research and monitoring are forever protected and accessible and that these data holdings will be linked to the latest in advanced information systems for resource analysis and decision making.

The boundaries between the various geoprocessing disciplines and technologies and between geographic and general information technology are rapidly disappearing. The USGS Information Technology requirements for the 21st century information superhighway include: wider network bandwidths enabling vast quantities of data to be transferred at the speed of light; open and interoperable software resources transparently sharable in a networked environment; integrated and seamless databases allowing for interdisciplinary solutions to social and scientific problems; and ever more sophisticated users linking in from local communities, schools, private industry, and federal agencies. **Gateway to the Earth** is the USGS vision for meeting those requirements for earth science data for the nation.

Gateway to the Earth at the national level will be built upon the existing National Spatial Data Infrastructure (NSDI) of the Federal Geographic Data Committee (FGDC) and the National Biological Information Infrastructure (NBII), USGS managed components of the National Information Infrastructure (NII). The NSDI, as defined by Presidential Executive Order 12906, consists of the technologies, policies, and people necessary to promote sharing of geospatial data throughout all levels of government, the private and non-profit sectors, and the academic community. The NBII is an electronic gateway to biological data and information maintained by federal, state, and local government agencies; private sector organizations, and other partners around the nation and the world. Because the USGS envisions an ever increasing role in providing solutions to complex social and environmental problems through interdisciplinary studies, the **Gateway to the Earth** program will necessarily include the integration of data and analysis tools from social science domain as well.

In Alaska, **Gateway to Prince William Sound and the Gulf of Alaska** will also build upon the Alaska Geographic Data Committee (the Alaska node of the FGDC) and its member organizations and activities, incorporating smaller ongoing efforts such as the Cook Inlet Information Management and Monitoring System (project /391) into the national information framework. Because the **Gateway** will be built upon and constantly migrated to the latest

technologies, it will provide for the evolution of EVOS data bases and related information systems in tandem with the evolution of Information Technology.

NEED FOR THE PROJECT

A. Statement of the Problem

During the past 10 years, there has been an enormous amount of data and information generated by Trustee Council-sponsored research. As we draw to a close in the current Restoration program, but particularly in preparation the Restoration Reserve research and monitoring activities, there is an ever-increasing need to catalog, archive, integrate, manage, and provide access to the accumulated information for the information community and stakeholders. This project proposes to incorporate all information management for the oil spill area into a dynamic system that takes advantage of the most advanced information technologies possible. These technologies are advancing rapidly and the costs of implementation are high. By providing for inclusion in a nationally defined program, obsolescence can be avoided, costs can be shared, national standards will be adhered to, and access provided to the most modern technology available.

B. Rationale/Link to Restoration

Information management on the grand scale posed in this proposal could be one of the biggest legacies that the Trustee Council might provide. The complex social issues and the biological, and physical science problems addressed in the restoration process require a comprehensive and integrated information system solution. The purpose of the Gateway program is to provide a coherent set of standards and interfaces that enables diverse users to find, get, and use natural science information in ways that are meaningful to them. It is intended for all user groups, and is the ultimate dynamic system, designed to incorporate and build on updates and future developments.

C. Location

This project would be developed and managed in Anchorage.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

PROJECT DESIGN

A. Objectives

For the areas of Prince William Sound and the Gulf of Alaska:

1. Develop Internet-based Information Technology solution to the data management, access, and integration of EVOS data bases and provide interoperable access to decision support and expert systems that assist with managing and conserving species, communities, habitats, and ecosystems. Components of the system will include: Infrastruture (network bandwidth); Interfaces (World-Wide Web); Processes (storage, processing and information management); Integratable Data (multidisciplinary, geospatial, topical) and; Tools (predictive models, dynamic simulation, decision support).

2. Develop and provide resource managers, Native communities, and all other stakeholders with spatial and nonspatial frameworks that access, integrate and synthesize information for determining causal relationships between habitat quality and quantity and fish, wildlife, and plant populations.

Design specifics:

- Maximum telecommunications network bandwidth
- Advanced Internet Search Engines that provide multiple options for data discovery and access. The system can be searched and browsed by subject, geo-reference, expertise, or temporal parameters
- Inclusion of tabular, geospatial, and non-geospatial data and
- Implementation of data and sofware interface standards that promote the interoperability concepts and specifications of National Programs such as the FGDC and Open GIS Consortium.
- User ability to share and use heterogeneous data and geoprocessing resources from multiple sources transparently in a networked environment.
- Simplified access to EVOS data and information for: scientists and professionals, government agencies and partners, local communities, schools and the general public.
- Online access to tools which support: predictive models, dynamic simulations, and decision support systems, statistical analysis, map and report product generation.

B. Methods

The USGS **Gateway to the Earth** initiative, for which the **Gateway to Prince William Sound** project could serve as a national prototype area, is presently in its initial design phase with accelerated design and initial implementation to begin in FY 2001. The methods which are proposed here focus primarily on the first year of the project, as the actual technical development will take place largely at the national level. The focus in Alaska will be on the identification of existing data bases and infrastructure; identification of collaborators, cooperators, and stakeholders; and the assessment of their present and future Information Technology needs. If Prince William Sound is selected as one of the National Protoypes then this information will used in the design and development of the **Gateway to the Earth**.

The USGS anticipates one person year of effort in FY00 for working on the development of a scoping document and the development of a workplan for the inclusion of the EVOS Gateway as a pilot of the USGS National Program. This proposal requests funding for half of that position, to be leveraged with matching funds from the U.S.G.S.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The USGS will be responsible for project implementation but will work closely with all federal, state, local government, non-government entities, and potential users in the design and implementation of the **Gateway to Prince William Sound**. By incorporating the requirements of the Alaska community into the national **Gateway to the Earth** Initiative, and by implementing the national Information Technology standards being developed by the USGS and other major federal partners (NASA, DOE, NOAA, and DOD) in 2001 Federal Information Budget Initiatives ($200 million) the EVOS trustees will be using highly leveraged dollars to build the **Gateway to Prince William Sound and the Gulf of Alaska** and the commitment of numerous federal agencies to maintain and expand upon the supporting Information System.

SCHEDULE

A. Measurable Project Tasks for FY 00

In FY 2000, the USGS will provide a comprehensive assessement of technical requirements of EVOS data bases and the community of current and potential users to serve as design factors in the development of an **Information Gateway to Prince William Sound and the Gulf of Alaska** (PWS/GOA). The USGS-Alaska will work closely with the **Gateway to the Earth** national team to insure the development of a PWS/GOA pilot that is inclusive and responsive to EVOS requirements.

The PWS/GOA Gateway represents a unique and complex set of requirements. Combined with the visibility of the EVOS response and restoration activities, PWS/GOA will make for an

excellent and challenging pilot site. The results of the first years effort will at a minimum establish a target for the national program that will in time encompass all U.S. Agencies' Earth Science Data holdings.

The following are Project Tasks for:

YEAR ONE, FY00

1. Identify and inventory existing multi-agency data sets from EVOS research and other relevant data holdings.
2. Determine options for management and integration of existing information
3. Identify additional cooperators for the project
4. Prepare a comprehensive list of information user requirements.
5. Prepare proposal for PWS and GOA as a Gateway Initiative
6. Obtain review of proposal from Trustee Council
7. Travel to Washington D.C. to lobby for PWS and GOA as a Gateway Initiative

YEAR TWO, FY01

1. Begin to work with **Gateway to the Earth** Design team to incorporate PWS/GOA data and user requirements.
2. Secure local server platform for design and testing of Gateway modules on EVOS data sets and applications.
3. Establish high bandwidth telecommunications link.
4. Re-assess user needs and data requirements in relation to new Information Technology capablilties.
5. Open PWS/GOA Gateway web-site to limited audience for experimentation and user assessment.
6. Publish data and software interface standards.

YEAR THREE, FY02

1. Continue interactions with **Gateway to the Earth** development group.
2. Customize EVOS applications with Gateway to PWS/GOA through interactions with EVOS scientists and the Alaska user community.
3. Open PWS/GOA Gateway to full public access.
4. Continue integration of new and relevant data bases and processing software.

B. Project Milestones and Endpoints

FY00 Develop proposal for Information Gateway to Prince William Sound and the Gulf of Alaska as a national initiative

FY01 Obtain national support and funding.
Open web-site to limited audience for experimentation and assessment

C. Completion Date

Development of an initial **Gateway Information System** and posting it on the World-Wide Web will be completed by the end of FY 2001. Because of the intended dynamic nature of the system, there is no final completion date. It is intended to be continually updated as new research information is made available, and the technologies inherent in its development are intended to advance along with the next generation of information tools.

PUBLICATIONS AND REPORTS

PROFESSIONAL CONFERENCES

ESRI User Conference, June, 2000.
National Geo-Data Forum, July, 2000

NORMAL AGENCY MANAGEMENT

Although positioning to design an information Gateway for Alaska potentially falls under normal agency management activities for USGS, targeting the EVOS database is only possible with leveraging by the EVOS Trustee Council.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

A Gateway interactive website of all EVOS information and databases would tremendously enhance coordination and restoration efforts for all participants in the EVOS program.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

PROPOSED PRINCIPLE INVESTIGATORS

Mark Shasby
Chief, National Mapping Division
U.S. Geological Survey
4230 University Drive, Suite 120
Anchorage, AK 99508
907-786-7000

Bill Seitz
Director, Alaska Biological Science Center
U.S. Geological Survey
1011 E. Tudor Rd.
Anchorage, AK 99503
907-786-3385

PRINCIPLE INVESTIGATORS

Mark Shasby-- Chief, Alaska Mapping Division of the USGS, co-Chairman, Alaska Geographic and Data Committee. Mr. Shasby has a Master's degree in Forest Ecology from Duke University and over 24 years of experience in management information systems, geographic information systems, and remote sensing systems design and implementation. Mr. Shasby has been employed with the USGS in Alaska since 1981, working on multi-agency solutions to natural resource assessment, remote sensing research, geographic information systems management, statewide spatial data base development projects, and the development of coordinated methodologies for implementing spatial data standards and policies. As Chairman of the Alaska Geographic Data Committe (AGDC), Mr. Shasby works with the entire Alaska community to facilitate coordination of all surveying, mapping, and spatial data activities as called for by the Federal Geographic Data Committee (FGDC). The AGDC is also the technical advisory group to the Alaska Land Managers Forum for matters related to geographic informations technology and mapping activities.

Bill Seitz--Wildlife Biologist; Director, Alaska Biological Science Center, USGS. Bill directs the research on fish and fisheries, birds, mammals, and ecosystem habitats for nearly 100 employees in Alaska. He oversees development of technical capabilities in the areas of biometrics, genetics, remote sensing and GIS and wildlife veterinary medicine. He oversee specially funded projects such as the *Exxon Valdez* oil spill program. He supports and maintains the USGS biological program in Alaska through interaction at the regional and national levels of USGS, and in Alaska with other federal and state agencies. Bill serves on the DOI Alaska Coordinating and Planning Group.

OTHER KEY PERSONNEL

Richard McMahon, Alaska Department of Natural Resources

LITERATURE CITED

2000 EXXON VALDEZ TRU__E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$43.8
Travel		$0.0
Contractual		$0.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$43.8
General Administration		$6.6
Project Total	$0.0	$50.4
Full-time Equivalents (FTE)		0.5
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		$200.0	$200.0		

Dollar amounts are shown in thousands of dollars.

Comments:

FY00

Prepared:

Project Number: 00447
Project Title: Information Gateway to Prince William Sound and the Gulf of Alaska
Agency: DOI: U.S. Geological Survey

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRU 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
M. Shasby	Chief, Alaska	GS-14	6.0	7.3		43.8
	USGS National Mapping Division					0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		6.0	7.3	0.0	
					Personnel Total	$43.8

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

FY00

Prepared:

Project Number:
Project Title: Information Gateway to Prince William Sound and the Gulf of Alaska
Agency: DOI: U.S. Geological Survey

FORM 3B
Personnel
& Travel
DETAIL

PROPOSAL FOR A DOCUMENTARY FILM ON CLAMS/ PARALYTIC SHELLFISH POISONING (PSP) AND SUBSISTENCE DISCUSSIONS WITH ELDERS ON SPRUCE ISLAND:

Project Number: 00449

Restoration Category: Clams - PSP and Subsistence

Proposer: Ouzinkie Tribal Council

Lead Trustee Agency:

Duration: 1st year 1 year project

Cost FY2000: [redacted] 85.0

Cost FY2001: 0.0

Cost FY 2002: 0.0

Geographic Area: Kodiak Island/Ouzinkie

Injured Resource/Service: Clams and Subsistence.

INTRODUCTION

The purpose is to produce a 20 to 30 minute film documentary film on Clams, Paralytic Shellfish Poisoning, (PSP), and Subsistence concerns and some round table discussions with our Elders on Subsistence. Natural Resources that are critical to our Health and well being and have been, since the beginning of our time such as herring and herring spawn, octopus, clams mussels and crab, and the list goes on. All or most were adversely effected by the *Exxon Valdez* oil spill.

Statement of need:

Subsistence resources that have been a staple to our people for many generations have been injured by the oil spill. Our resources need to be recorded, documented and monitored by our people in the future and for the future. The safety concerns about those resources contaminated by the oil spill are still a virtual reality. This project will provide our people with the opportunity to be a part of the recovery and healing process.

Rational/Link to Restoration:

Starting April 1999, Ouzinkie will be participating in a trial - through Jelled Batik Ltd. to evaluate the effectiveness of a new screening test for PSP and amnesic shellfish poisoning.

The new generation of test kits that will be used are similar to a home pregnancy test. Fifty samples over the summer from possibly August or September, 1999 to October, 2000 will be done in cooperation with Jelled Batik Ltd. and the Ouzinkie Tribal Council.

The intent of this project is to contribute to the eventual restoration of clams, an understanding of PSP and a sure way of detecting PSP and amnesic shellfish poisoning; also, to gain some traditional knowledge, gained from years of experience from speaking with some elders on this issue. Producing this video will enhance the eventual restoration of our clams and reference we can always look back to.

Location:

Filming will take place near our village of Ouzinkie on designated beach sights.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

This project is being proposed by the Ouzinkie Tribal Council. The council will be involved in the selection of a film contractor and the content of the film.

Project Design:

A. Objectives:

The overall objective of this project is to promote the recovery of clams and bring awareness to our communities on PSP issues and concerns in and around the Kodiak Archipelago.

B. Methods:

A 20 - 30 minute documentary film will be produced through a professional service contract. The film will document subsistence clamming on or near the village of Ouzinkie. The film crew will visit the village on yet to be determined dates to document subsistence clamming and the testing of PSP, and to speak with and document a round table of Elders discussing Subsistence.

C. Cooperating Agencies, Contract, and Other Agency Assistance

The production and post production work on the film will be contracted to an experienced film maker who has the expertise to make a quality film. In contracting out for this production the proposers want to hire someone who will actually create and produce the product rather than contracting out for creative talent. By hiring a video production company will create a story line before shooting the film. All footage will be shot on location and include interviews with member of the community and footage of harvesters. Once the film is completed the production company will edit the footage using digital state of the art editing equipment.

SCHEDULE:

A. Measurable Project Tasks for FY2000 (October 1, 1999 - September 30, 2000)

October 1, 1990	Project approval.
October - November, 1999	Develop contract guidelines, evaluate bids and award contract.
December, 1999	Contractor will develop story line for film.
January, 2000 through an undetermined time.	Film crew travel to Ouzinkie to start footage of Elders and digging of clams on designated beaches.
October, 1999	Edit film.
November - December, 1999	Contractor will provide completed film and deliver one hundred (100) copies.

Completion Date

December, 2000

PUBLICATION AND REPORTS

The film will be widely distributed to federal and state agencies, non-governmental agencies, and interested parties. Showings will take place in Ouzinkie, Anchorage and ___?

PROFESSIONAL CONFERENCES

The film may be shown at professional conferences.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will contribute to various restoration strategies including: Sound Ecosystem Assessment; the Enhancement of Subsistence Resources; Increase Involvement of Subsistence Users in the Restoration Process: Through Local and Traditional Ecological Knowledge. We plan to film sessions when local people discuss their knowledge of Subsistence.

PROPOSED PRINCIPAL INVESTIGATOR

Paul Panamarioff
President, Ouzinkie Tribal Council
Ouzinkie, Alaska
(907) 680-2259

PRINCIPAL INVESTIGATOR

Paul Panamarioff
Mr. Panamarioff was born in Ouzinkie and is a life long harvester of Subsistence foods. He is president of the Ouzinkie Tribal Council.

OTHER KEY PERSONNEL

Kenneth Anderson, a life long resident of Ouzinkie; Kenneth is our Natural Resource Specialist, and has been digging clams at designated beaches and sending out samples to the Palmer Laboratory for PSP testing for the past two years.

Influence of Exogenous Zooplankton Assemblages on Juvenile Herring Nursery Areas

Project number:	00451
Restoration Category:	Research
Proposer:	University of Alaska Fairbanks
Lead Trustee Agency:	ADFG
Cooperating Agencies:	
Alaska SeaLife Center:	No
Duration:	1st year, 1-year project
Cost FY 00:	$47,744
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pacific herring

ABSTRACT

Previous EVOS Restoration projects noted the importance of the nearshore environment for juvenile Pacific herring nurseries. Studies have found that Gulf of Alaska (GOA) derived carbon may be transported into Prince William Sound (PWS) neritic environments. The zooplankton community in central PWS and in herring nursery bays has been described. Stable isotope analyses showed that GOA carbon influences PWS food webs. The importance of central PWS and GOA zooplankton to the neritic nursery areas and diets of juvenile herring has not been studied. We propose to analyze zooplankton composition with respect to physical measurements from archived samples collected in neritic and central PWS from the spring of 1996 and 1997.

INTRODUCTION

The Prince William Sound (PWS) Pacific herring (*Clupea pallasi*) population crashed in 1993, ceasing commercial harvest until the winter of 1996 – 1997 when a limited fishery took place. In 1994, the Sound Ecosystem Assessment (SEA) program was established by the EVOS Trustee Council in part to study the processes influencing the recovery of herring populations in PWS.

Overwinter mortality of juvenile herring was a result of low food availability, energetic condition in the fall, and winter duration (Paul et al. 1998, Foy and Paul in press, Patrick et al. in prep.). Temporal variability in energy density of juvenile herring revealed that age 0 fish often have difficulty overwintering because it is difficult for them to store enough energy during their first growing season (Paul et al. 1998). Knowledge of variability in the prey composition in nursery areas would provide insight into the condition of juvenile herring prior to a high mortality period in winter. Higher energy dense prey have been found to be important for first feeding age 0 herring that have been starving during there first overwinter period (Foy and Paul 1999). Currently it is unknown if these prey are produced by the neritic PWS plankton community or are transported from the GOA and until this is clarified it is impossible to determine the importance of physical transport processes to the success of juvenile herring.

Spatial differences in energy density of juvenile herring suggested that food composition was different among bays (Kline and Paul in press, project 97320-I and project 97320-U). Carbon stable isotopes also showed that fish with higher energy density were depleted in ^{13}C corresponding to Gulf of Alaska derived carbon. Subsequently, spatial and temporal differences were found in diet compositions of juvenile herring confirming the spatial difference in prey composition and availability (Foy and Norcross 1999). Herring assimilation rates based on stomach content energy density were also different among bays suggesting variable energy density of prey ingested. Gradients in species composition and abundance of zooplankton taxa have been found among and between bays (Foy unpublished data).

One objective of the Juvenile Herring Distribution and Habitats project (\320-T) within the SEA program was to model the nursery habitats of juvenile herring. In particular, the feeding ecology of juvenile herring and prey compositions found in four bays within PWS were described (Foy and Norcross 1999, Stokesbury et al. 1998, Stokesbury et al. 1997,). Juvenile herring and vertical zooplankton tows were collected in Eaglek, Simpson, Whale, and Zaikof Bays in the spring of 1996 and 1997. Zooplankton were also collected from central PWS locations in the spring of 1996 and 1997 by EVOS funded project \320-H. We propose to compare these two datasets to describe the interaction of nearshore (within bays) zooplankton communities with that of offshore (central PWS) sites. Timing and the degree of influence that larger zooplankton communities have on nearshore environments may be important for the survival of juvenile herring.

In order to facilitate the understanding of trophic links between juvenile herring nursery areas and central PWS, stable isotope data previously collected (project \320-?) for juvenile herring and macrozooplankton will be utilized. We will assess, as best we can with existing data, the importance of Gulf of Alaska carbon in the Spring of 1996 and 1997 to herring nursery areas by comparing the isotope signatures and the species compositions.

Detecting physical attributes of nearshore areas that contribute to enhancing or preventing the transport of zooplankton into nursery areas is important for assessing the importance of

exogenous prey. Physical variables have been collected that may account for the distributions of zooplankton prey in the nearshore areas (Gay and Vaughan in prep.). The extent of GOA and central PWS zooplankton influence on herring nursery areas may then become predictable based on environmental conditions.

NEED FOR THE PROJECT

A. Statement of Problem

Pacific herring has been listed as a "Recovering Resource." In order to understand the dynamics of continued recovery and estimate future success of the population, the condition of nursery areas must be quantified. Therefore, knowledge of the link between nursery areas and processes adjacent to the bays and PWS is necessary.

B. Rationale/Link to Restoration

This project examines the importance of carbon transport into juvenile herring nursery areas. With changing environmental conditions in the North Pacific Ocean, it will be necessary to predict the condition of pre-recruit herring in order to manage future fisheries. Knowledge of the relative importance of food sources derived outside nursery areas to the success of the herring population will enhance management's predictive capabilities since there will be a better understanding of the consequences of high and low transport rates of GOA water into PWS. Better management of the population will act to enhance the recovery of Pacific herring. Herring are also important forage species for several sea birds, mammals, and fishes that were impacted during the 1989 oil spill, and improving the understanding of herring recruitment processes will be valuable to managers and these resources.

C. Location

The location of sampling was Prince William Sound. Results of this project will be applicable to and have consequences for trophic relationships of other "Recovering" and "Not Recovering" resources as well. The importance of high energy dense prey availability to rearing juvenile fish could be applicable to a large range of species that rear in fjords and bays.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

The data collected for this proposed project was a part of the SEA project. Traditional knowledge of herring distribution was used in the original sampling design. Local commercial fishing vessels were used in our sample collections. Local Cordovans and other Alaska residents were employed as technicians and vessel crew. Supplies, fuel, and equipment were purchased locally. Information resulting from this project will be made readily available to local fisheries managers.

PROJECT DESIGN

A. Objectives

The research objectives of this project are:

1. Analyze species composition and local biomass of nearshore and offshore zooplankton communities from previously collected data.

2. Combine data from previous studies to relate isotopic signatures of juvenile fish in the bays to species composition found in the diets.

3. Examine the importance of physical features within four sites to the influence of central PWS species assemblages on juvenile herring nursery areas.

B. Methods

We hypothesize that some zooplankton species found in central PWS will be transported to the nearshore environment and will play important roles in local food webs. In particular, juvenile herring will be dependent on this food source for high energy content prey. We also hypothesize that carbon from Gulf of Alaska sources will also be transported to the bays in the same manner where it will play a critical role in the energetics of age 0 herring.

In order to test these hypotheses, we will mine current databases from projects \320-T and \320-H for zooplankton composition, abundance, and biomass. Species taxa will be grouped according to ordination techniques on Bray Curtis dissimilarities to examine zooplankton composition. Ordination axes will then be compared to sampling location in an analysis of variance. It may be necessary to look at time lags between samples to detect delayed occurrences of species to the nearshore environment accounting for sampling periods.

Local physical data (temperature, salinity, and currents) collected during the previous sampling cruises will be used to suggest mechanisms for central PWS influence on the nearshore environments. Also, previously published stable isotope data will be compared to the species distributions found in the herring nursery areas and may account for the origin of carbon utilized in nearshore food webs.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The University of Alaska Fairbanks is the only entity in this proposal; however, data collected by the PWS Science Center staff during the SEA program will be included in the analysis.

SCHEDULE

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

October 1 – November 1:	Mine databases from previous projects to complete solid design for statistical comparison
January 18 – 28 (3 of these days):	Attend Annual Restoration Workshop
February 23 – 26:	Present data at 18th Wakefield Fisheries Symposium
March 1 – March 31:	Write and submit manuscript to peer reviewed journal
April 15:	Submit annual report

B. Project Milestones and Endpoints

November 1 – December 31:	Objective 1: Analyze zooplankton composition data
January 1 – February 28:	Objective 2 and 3: Compare physical data and stable isotope data from the database and published articles to the species composition results

C. Completion Date

March 31, 2000

PUBLICATIONS AND REPORTS

Final Report (April 15, 2001)

Influence of exogenous zooplankton assemblages on the nursery areas of juvenile herring. Foy, R. J. and A. J. Paul. Canadian Journal of Fisheries and Aquatic Sciences.

PROFESSIONAL CONFERENCES

During FY 00, we will attend the Annual EVOS Restoration Workshop in January

Data will be presented at the 18th Wakefield Fisheries Symposium: Herring 2000, An international symposium on expectations for a new millennium. Anchorage, Alaska. February 23 – 26. A presentation will be given on the feeding ecology of juvenile Pacific herring.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will address a series of questions raised from previous and continuing Restoration projects about the mechanisms that supply energy to the food web that supports injured and slowly recovering species. Information regarding transport of carbon resources to nearshore environments will enhance the findings about species interdependence and energy flow derived in the SEA, NVP, and APEX projects. We will attempt to identify the linkage between the Gulf of Alaska derived carbon and nearshore environments as was suggested by stable isotope analyses in project \320-I. This project will also utilize the biological data already collected in PWS to enhance the interpretation of food web dependencies which may be useful to project \393.

PROPOSED PRINCIPLE INVESTIGATORS

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Education:
Ph.D., Hokkaido University, Hokkaido, Japan, 1987
M.S., University of Alaska, 1973
B.S., University of Massachusetts, Amherst, 1969

Experience:
Biological Oceanography, Institute of Marine Science, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 1971–present.

Publications:
Clayton, L. A., A. J. Paul, and J. M. Paul. 1997. Timing of hatching and length frequency profiles of walleye pollock larvae in Resurrection Bay Alaska, Spring 1991. *Fish. Bull.*, in press.

Paul, J. M., A. J. Paul, and W. Barber. 1997. The reproductive biology and distribution of *Chinoecetes opilio* from the northeastern Chukchi Sea. *Am. Fish. Soc. Symposium* 19, in press.

Paul, A. J. and J. M. Paul. 1997. Male Tanner crab carapace widths at previous intermolt estimated from laboratory growth, Kachemak Bay, Alaska. *Alaska Fishery Research Bulletin.* 3:64–67.

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Munehara. H., J. M. Paul, and A. J. Paul. 1994. Occurrence of *Scorpaeniformes* larvae during spring in a fjord, Resurrection Bay, southcentral Alaska. *Japanese J. Ichth.* 41:73–75.

Paul, J. M., A. J. Paul, and A. Kimker. 1994. Compensatory feeding capacity of two brachyuran crabs, Tanner and Dungeness, after starvation periods like those encountered in pots. *Alaska Fisheries Research Bulletin* 1(2):184–187.

Paul, A. J. and K. O. Coyle. 1993. Taxa composition and biomass of the surface dwelling crustaceans during spring pycnocline formation in a glacially influenced Alaskan bay. *J. Crust. Biol.* 13(3):594–600.

McGurk, M. D., A. J. Paul, K. O. Coyle, D. A. Ziemann, and L. J. Haldorson. 1993. Relationships between prey concentration and growth, condition and mortality of herring, *Clupea pallasi*, larvae in an Alaskan subarctic embayment. *Can. J. Fish. Aquat. Sci.* 50:163–180.

Coyle, A. J. and A. J. Paul. 1992. Interannual differences in prey taken by capelin, herring, and red salmon relative to zooplankton abundance during the spring bloom in a southeast Alaskan embayment. *J. Fish. Oceanogr.* 1:294–305.

Paul, A. J., K. O. Coyle, and L. Haldorson. 1991. Interannual variations in copepod nauplii prey for larval fish in an Alaskan bay. *ICES J. Mar. Sci.* 48:157–165.

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Coyle, K., A. J. Paul, and D. A. Ziemann. 1990. Interannual variation of copepod population during the spring bloom in an Alaskan subarctic embayment. *J. Plankton Res.* 12:759–797.

Paul, A. J., K. O. Coyle, and D. A. Ziemann. 1990. Timing of spawning of *Thysanoessa raschii* (Euphausiacea) and occurrence of their feeding-stage larvae in an Alaskan bay. *J. Crust. Biol.*

Paul, A. J., K. O. Coyle, and D. A. Ziemann. 1990. Variations in egg production rates by *Pseudocalanus* spp. in a subarctic Alaskan bay. *J. Crust. Biol.* 10:648–658.

Harris, R., T. Nishiyama, and A. J. Paul. 1986. Carbon, nitrogen, and caloric content of eggs, larvae, and juveniles of the Alaska pollock, *Theragra chalcogramma. J. Fish. Bio.* 29:87–98.

Paul, A. J. 1983. Light, temperature, nauplii concentrations, and prey capture by first feeding pollock larvae, *Theragra chalcogramma. Mar. Ecol. Prog. Ser.* 13:175–179.

OTHER KEY PERSONNEL

A Research Associate will be responsible for gathering previously collected and archived data from the appropriate databases. He will do all analyses and lead the publication efforts arising from this study.

LITERATURE CITED

Foy, R. J. and A. J. Paul. In press. Winter feeding and changes in somatic energy content for age 0 Pacific herring in Prince William Sound, Alaska. *Trans. Am. Fish. Soc.* 00:0000–0000.

Foy, R. J. and B. L. Norcross. In press. Spatial and temporal differences in the diet of juvenile Pacific herring (*Clupea pallasi*) in Prince William Sound, Alaska. *Can. J. Zool.* 00:0000–0000.

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Kline, T. C., and A. J. Paul. In press. Isotopic signature and somatic energy content of young of the year Pacific herring at two sites in Prince William Sound, Alaska: implications for trophic studies. *Can. J. Fish. Aquatic Sci.* 00:0000–0000.

Patrick, V. E., D. M. Mason, R. J. Foy, B. L. Norcross, A. J. Paul, K. D. E. Stokesbury, and T. Kline. In prep. Effects of fall physiological condition and winter water temperature on over-winter survival of age-0 Pacific herring: A modeling synthesis. *Fish. Oceanogr.* 00:0000–0000.

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Stokesbury, K. D. E., E. D. Brown, R. J. Foy, and B. L. Norcross. 1997. Juvenile herring growth and habitats. *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 96320T), University of Alaska Fairbanks, Institute of Marine Science, Fairbanks, Alaska.

Stokesbury, K. D. E., E. D. Brown, R. J. Foy, and B. L. Norcross. 1998. Juvenile herring growth and habitats. *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 97320T), University of Alaska Fairbanks, Institute of Marine Science, Fairbanks, Alaska.

2000 EXXON VALDEZ TRU E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$0.0						
Travel		$0.0						
Contractual		$47.8						
Commodities		$0.0						
Equipment		$0.0						
Subtotal	$0.0	$47.8			Estimated FY 2001	Estimated FY 2002		
General Administration		$3.3						
Project Total	$0.0	$51.1						
Full-time Equivalents (FTE)		0.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY00

Prepared:

Project Number: [redacted] 00451
Project Title: Influence of Exogenous Zooplankton Assemblages on Juvenile Herring Nursery Areas
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRU E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$30.6
Travel		$1.4
Contractual		$1.5
Commodities		$0.8
Equipment		$4.0
Subtotal	$0.0	$38.3
Indirect		$9.5
Project Total	$0.0	$47.8
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:

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

FY00

Prepared:

Project Number: 00xxx
Project Title: Influence of Exogenous Zooplankton Assemblages on Juvenile Herring Nursery Areas
Name: A. J. Paul

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
Paul. A. J.	Principal Investigator/Professor		0.3	8.1		2.4
TBN	Research Associate		6.0	4.7		28.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		6.3	12.8	0.0	
					Personnel Total	$30.6

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 2000
Seward to Anchorage		0.3	2	8	0.1	1.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$1.4

FY00

Prepared:

Project Number: 00xxx
Project Title: Influence of Exogenous Zooplankton Assemblages on Juvenile Herring Nursery Areas
Name: A. J. Paul

FORM 4B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
Communication, copying, postage, shipping	0.5
Page fees	0.5
Reprints	0.5
Contractual Total	$1.5

Commodities Costs:	Proposed
Description	FY 2000
Statistical software	0.6
Office supplies	0.1
Presentation supplies	0.1
Commodities Total	$0.8

FY00

Prepared:

Project Number: 00xxx
Project Title: Influence of Exogenous Zooplankton Assemblages on Juvenile Herring Nursery Areas
Name: A. J. Paul

FORM 4B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2000
Description			
Computer upgrade			4.0
			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**	$4.0

Existing Equipment Usage:	Number of Units	
Description		

FY00

Prepared:

Project Number: 00xxx
Project Title: Influence of Exogenous Zooplankton Assemblages on Juvenile Herring Nursery Areas
Name: A. J. Paul

FORM 4B
Equipment
DETAIL

Project Title: Monitoring Recovery of Injured Species Following Removal of Introduced Foxes

Project Number:	00453
Restoration Category:	Restoration Monitoring
Proposer:	Alaska Maritime National Wildlife Refuge
Lead Trustee Agency:	DOI
Cooperating Agencies:	None
Alaska SeaLife Center:	No
Duration:	2 years
Cost FY-00: Cost FY-01	47.4 k 10.0 k
Geographic Area:	Shumagin Islands
Injured Resource/Service:	Black Oystercatcher, Pigeon Guillemot

ABSTRACT

Introduced arctic foxes were removed from Simeonof and Chernabura islands in the outer Shumagin Island group in 1994 and 1995 (Projects 94041, 95041, 96101) to restore populations of black oystercatchers and pigeon guillemots , two species of birds injured by the *T/V Exxon Valdez* oil spill. Oystercatcher and guillemot populations were much lower on Simeonof and Chernabura than on nearby fox-free islands in 1995, but they are expected to recover to historic levels following fox removal. We propose to resurvey populations of oystercatchers and guillemots at Simeonof and Chernabura and at nearby "reference" sites in 2000, five years following fox removal, to determine whether restoration is underway.

INTRODUCTION

In order to restore black oystercatchers (*Haematopus bachmani*) and pigeon guillemots (*Cepphus columba*), two species injured by the T/V *Exxon Valdez* oil spill (Piatt et al. 1990, Andres 1993, Oakley and Kuletz 1994, 1996), introduced arctic foxes (*Alopex lagopus*) were removed from Simeonof and Chernabura islands in the Shumagin Islands group near the western edge of the oil's path (Projects 94041, 95041, 96101). Removal of these introduced predators was one of the best options available for direct restoration of injured populations. Foxes were removed in 1994 and 1995 (Bailey 1994, Byrd et al. 1996).

Populations of oystercatchers and guillemots were estimated on Simeonof and Chernabura and on nearby fox-free islands to record levels of nesting birds on the islands with foxes compared to "reference" sites without foxes and to use information from the latter sites to predict expected levels for restored populations on Simeonof and Chernabura (Byrd et al. 1996, Byrd et al. 1997). No oystercatchers successfully nested on Simeonof or Chernabura in 1994 when foxes were present. Nevertheless, failed or non-breeding birds, including some "pairs", were recorded on both islands. Apparently, oystercatchers periodically attempted to nest on islands with foxes but usually lost their eggs or chicks to these predators. Following fox removal, these pairs should successfully nest. Indeed, we found 2 oystercatcher nests on Simeonof and 3 nests on Chernabura in 1995, the first breeding season following fox removal. In contrast to oystercatchers, which are almost completely excluded from nesting on islands with foxes, pigeon guillemots are able to sustain reduced nesting populations because they nest in crevices, a proportion of which are inaccessible to foxes. In spite of this protection, foxes prey on guillemots, and we predicted that guillemot populations would increase following removal of introduced foxes (Byrd et al. 1997). Studies elsewhere in Alaska have suggested that guillemot and other marine bird populations demonstrate substantial recovery 5-10 years following fox removal (Bailey 1993, Byrd et al. 1994).

The project proposed herein is designed to monitor populations of oystercatchers and guillemots five years following fox removal to document levels of recovery. We propose to repeat surveys conducted in 1994 and 1995 at Simeonof and Chernabura islands and at the "reference" fox-free sites, Bird, Atkins, and Herendeen islands. Comparisons will provide a basis for evaluating the restoration effort.

NEED FOR THE PROJECT

A. Statement of Problem

The Exxon Valdez Oil Spill Trustee Council funded the removal of introduced foxes from islands to restore populations of black oystercatchers and pigeon guillemots, two species injured by oil spilled from the *T/V Exxon Valdez.* The proposed survey is needed to determine the response of bird populations in the first five years following fox removal.

B. Rationale

Arctic foxes were introduced to a number of Alaskan Islands for fur farming prior to WWII (Bailey 1993). These introduced predators extirpated or substantially reduced populations of native birds. Colonial nesting seabirds and conspicuous terrestrial birds were particularly severely affected. Removal of foxes is a proven restoration technique for native biodiversity in Alaska (Bailey 1993, Byrd et al. 1994). A survey is needed to document responses of oystercatcher and guillemot populations following fox removal to determine effectiveness of the fox removal at Simeonof and Chernabura in helping to restore these injured species.

C. Summary of Major Hypotheses and Objectives

We propose to estimate the number of breeding pairs and the number of non-breeding individuals of black oystercatchers and the number of individual pigeon guillemots at Simeonof and Chernabura islands during June 2000. Furthermore, numbers of oystercatchers and guillemots would be estimated at the "reference" sites used in 1994 and 1995; Bird, Herendeen, and Atkins islands.

D. Completion Date

Work will be completed in FY-2001.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Results of the surveys will be summarized in a format (probably a poster) appropriate for sending to various organizations (City Office, School, Post Office, Aleutian Commercial Company) at Sand Point, the community closest to the study site.

PROJECT DESIGN

A. Objective

Document the response of black oystercatcher and pigeon guillemot populations in the first five years following the removal of introduced foxes

B. Methods

Oystercatcher Counts

Similar to methods used in surveys in 1994 and 1995, black oystercatchers would be counted by a two-person team cruising the perimeter of islands in an inflatable boat within 50 m of shore during June, the incubation period. This is the period when pairs are territorial and most

conspicuous. The best time to count oystercatchers is from approximately 2 hours before low tide until one hour after low tide, the period when they are most actively foraging (Andres 1993). Coastlines would be surveyed at least three times to estimate the mean number of non-breeding individuals. For each oystercatcher observation, the location and status (single, pair, or larger group) will be recorded. Beaches also will be checked on foot to determine whether nests or territorial pairs are present. This should provide a complete census of breeding pairs, since territorial pairs are conspicuous due to calling, reluctance to leave, and broken wing displays.

Guillemot Counts

Reports in the literature provide differing views on the best time to count guillemots. The relative influence of tide stage, time of day, and time of the breeding season on attendance of guillemots at breeding colonies apparently varies among areas (e.g. California, Ainley and Boekelheide 1990; British Columbia, Drent 1965, Vermeer et al. 1993; and Prince William Sound, Sanger and Cody 1993). For comparison among sites and years, it appears the optimum time to census breeding pigeon guillemots is morning hours during the incubation period (about mid-June to mid-July, Day 1977) and within several hours of high tide. Although peak numbers of guillemots occurred at Prince William Sound colonies during the pre-laying period (Sanger and Cody 1993), Vermeer et al. (1993) recommend counts between early incubation and early chick stages when numbers are least variable. Hence, we will follow the same procedures used in 1994 and 1995 (Byrd et al. 1995) and count guillemots during the first few hours following first light on days during the incubation period. Due to hourly and daily variation in attendance of guillemots at colonies, at least four replicate surveys would be made to estimate guillemot populations.

Counts will be conducted by two individuals slowly circumnavigating islands in an inflatable boat about 50 m offshore during periods of good visibility and relatively calm seas. All guillemots within approximately 100 m of shore will be recorded. Island coastlines were subdivided into segments for these surveys in 1994 and 1995, and counts in 2000 will be recorded within the same segments used in earlier years. Concentrations of four or more birds on the water or land near guillemot nesting habitat will be delineated as accurately as possible on maps.

Data Analysis

Since we are essentially censusing pairs of black oystercatchers, a direct comparison will be made between 1994, 1995, and 2000 for each island. The mean number of non-breeding oystercatchers for each island will be used to calculate the proportion of birds not paired. This index was used in 1995 to evaluate the impacts of introduced foxes; the proportion of oystercatchers not paired being much higher on Simeonof and Chernabura than on nearby fox-free islands. The indices for each island in 2000 will be compared to values in 1995 with 2 x 2 contingency tables using the log Likelihood ratio test.

For pigeon guillemots, data for each island will be expressed as means of replicate counts of the coastline on *n* different mornings in 1995 and 2000. To test the null hypothesis of no difference

between years, we will use independent sample t tests. Coefficients of variation varied among islands. Estimates were over 40% on the fox inhabited islands, but averaged approximately 20% on fox-free islands in 1995. Assuming variation among counts will be somewhat more like "normal" in 2000, say 25%, we would expect to be able to detect differences in average numbers of guillemots between 1995 and 2000 as small as 25% (at a 0.1 level of significance and 90% power) with 4 replicate counts..

C. Cooperating Agencies, Contracts and Other Agency Assistance

The refuge would provide employee's time, equipment, and some ship support. Simeonof also is a National Natural Landmark, and the National Park Service, who administers this program would provide one employee to help conduct the surveys.

SCHEDULE

A. Measurable Project Tasks for FY 00 (Oct. 1, 1999-Sept. 30, 2000)

April 15 to May 20:	Refine study plan, arrange logistics, recruit seasonal personnel
May 21 - June 5 :	Train seasonal employees, make final preparations for field work
June 10-18:	Conduct surveys in the Shumagins
July 1-Sept 30:	Summarize and enter data, maintain and store field gear

Measurable Project Tasks for FY 01 (Oct. 1, 2000-Sept. 30, 2001)

Oct 1-Dec 30, 2000:	Analyze data, prepare poster, prepare for meeting presentations
Jan 2001:	Present results at EVOS workshop and Pacific Seabird Group
Feb -Mar:	Prepare final report and manuscript on FY 00 findings
April 15:	Submit final report to Trustee Council and send manuscript to Colonial Waterbirds

B. Project Milestones and Endpoints

May 2000	Study plan complete, Crew hired and trained
June	Oystercatcher and guillemot populations surveyed
Sept	Data summarized
Dec	Data analyzed, posters prepared and sent to Sand Point
Jan 2001	Presentations given at meetings
Apr 15, 2001	Final report submitted and manuscript submitted to Colonial Waterbirds

C. Completion Date

The project would be complete in April 2001 except for revising the final report and working through the publication process.

PUBLICATIONS AND REPORTS

The final report would be submitted April 15, 2001 and a note entitled, "Response of black oystercatchers and pigeon guillemots to removal of introduced foxes" would be submitted to Colonial Waterbirds in April 2001.

PROFESSIONAL CONFERENCES

Results would be presented at the annual meeting of the Pacific Seabird Group.

NORMAL AGENCY MANAGEMENT

The Fish and Wildlife Service has not funded surveys following fox removal except at a single site in the western Aleutian Islands set up for that reason in the mid-1970s. Information from that site would be of use only conceptually to demonstrate effects of this restoration project in the Shumagin Islands, 2000 km away.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project contributes to the overall restoration effort for oystercatchers (e.g., projects 93035 and 94020) and pigeon guillemots (e.g. ,projects 93034, 94173, and 95163F). Monitoring methods used were similar in all projects.

Supplemental funding from FWS (salary of permanent employees, equipment, time required to get the M/V Tiglax to the project site) and NPS (salary of permanent employee) will help to leverage the funding supplied by the Trustee Council. Furthermore, it is possible that FWS or NPS will provide some of the vessel days free of charge to the Trustee Council if normal agency functions in the area coincide with this project. That will not be known until the beginning of FY 00 (about Feb or Mar 2001), but it is possible that the agencies will provide up to 4 of the 8 vessel days needed to do the project. In that case, funding for agency-provided vessel days will be returned to the Trustee Council (up to 16.6 k).

PROPOSED PRINCIPAL INVESTIGATOR

Name:	G. Vernon Byrd
Affiliation:	DOI, USFWS, Alaska Maritime NWR
Mailing Address:	2355 Kachemak Bay Drive, Suite 101, Homer, AK 99603
Phone:	907-235-6546
Fax:	907-235-7783
E-mail:	Vernon_Byrd@fws.gov

PRINCIPAL INVESTIGATOR

G. Vernon Byrd received a B.S. degree in wildlife management from the University of Georgia in 1968, did post-graduate studies in wildlife biology at the University of Alaska Fairbanks in 1975, and completed a M.S. degree in wildlife resources management (with an emphasis in applied statistics) from the University of Idaho in 1989. Thesis research was on kittiwakes (*Rissa* spp.) and murres (*Uria* spp.) in the Pribilof Islands. Mr. Byrd has worked for the U.S. Fish and Wildlife Service for over 25 years, focusing on studies of marine birds in Alaska and Hawaii. His major interests have centered around monitoring long-term trends in seabird populations, including numbers of birds and reproductive performance at colonies, and he has studied the response of marine birds to introduced predator removal. He has written more than 40 scientific papers and 50 U.S. Fish and Wildlife Service reports on field studies, and he has presented approximately 20 papers on seabirds at scientific meetings. Mr. Byrd currently serves as supervisory wildlife biologist at the Alaska Maritime National Wildlife Refuge. He led the surveys of oystercatchers and guillemots in the Shumagins in 1995, and was project manager for projects 94041 and 95041.

Relevant Publications

Byrd, G.V., E.P. Bailey, and W. Stahl. 1997. Restoration of island populations of black oystercatchers and pigeon guillemots by removing introduced foxes. Colonial Waterbirds 20:253-260.

Byrd, G.V., J.L. Trapp, and C.F. Zeillemaker. 1994. Removal of introduced foxes: A case study in restoration of native birds. Transactions of the 59th North American Natural Resources Conference: 317-321.

Jones, R.D., Jr. and G.V. Byrd. 1979. Interrelations between seabirds and introduced animals. Pages 221-226 *in* J.C. Bartonek and D.N. Nettleship (eds.) Conservation of marine birds of northern North America. U.S. Fish and Wildlife Research Report No. 11.

OTHER KEY PERSONNEL

Name:	Steven Ebbert
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Steve Ebbert received a Bachelor of Science Degree in Forestry from Purdue University in 1984. The emphasis of his undergraduate degree was wildlife management and he was a cooperative education student with Indiana's Division of Wildlife. As a senior, Steve arranged for a one-of-a-kind special problems class sponsored by an adjunct professor with Animal Damage Control, at that time within the U.S. Fish and Wildlife Service.

Mr. Ebbert earned a Master of Science in Wildlife and Fisheries from Texas A&M University. For his thesis project, Mr. Ebbert tested and improved the effectiveness and selectivity of a new coyote bait delivery system for use with predacides, reproductive inhibitors, markers, or biological agents. He assisted with other research projects in Texas involving predator trapping, radio-telemetry and mammal census techniques.

Starting in 1987, Mr. Ebbert worked with U.S.D.A.'s Predator Ecology and Behavior Project, a captive coyote facility and field station of the Denver Wildlife Research Center. He assisted with research directed at the ecology, behavior, and environmental impact of predators, primarily the coyote, and the development of depredation control techniques. While in Utah, Mr. Ebbert completed over 50 quarter hours of graduate courses in specialized courses such as exotic wildlife management, population ecology, landscape ecology, wildlife competition and remote sensing.

Before coming to the Alaska Maritime National Wildlife Refuge in 1995, Mr. Ebbert was employed with the U.S. Fish and Service's Division of Realty in Anchorage. With Realty, he used a geographic information system (GIS) to model wildlife habitat value of private land inside refuge boundaries. He compiled wildlife survey data to update resource maps used in the GIS.

Mr. Ebbert currently serves as the Wildlife Biologist in charge of the Alaska Peninsula Unit of the Alaska Maritime National Wildlife Refuge. He participated in guillemot and oystercatcher surveys at Simeonof and Chernabura in 1995, and has overseen marine bird survey and fox removal projects on his unit since 1995.

Relevant Publications:

Fagre, D. B. and S. M. Ebbert. 1989. Development and testing of the coyote lure operative device. Pages 235-240 in A. C. Crabb and R. E. Marsh, ed., Proc. 13th Vertebrate Pest Confer. Univ. Calif., Davis.

Ebbert, S. M. 1988. Field evaluation and improvement of a new system for delivering substances to coyotes. M.S. Thesis. Texas A&M University, College Station, 145pp.

Ebbert, S. M. and D. B. Fagre. 1988. Importance of attractant qualities for improving a new coyote delivery system. Pages 189-194 in D. W. Uresk, G. L. Schenbeck, R. Cefkin, technic. coordins., Proc. 8th Great Plains Wildl. Damage Control Workshop. USDA For. Serv., Rocky Mtn. For. Range Exp. Sta., Rapid City, S.D.

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Byrd, G.V., E.P. Bailey, and W. Stahl. 1997. Restoration of island populations of black oystercatcher and pigeon guillemot by removing introduced foxes. Colonial Watebirds 20:253-260.

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Piatt, J., C.J. Lensink, W. Butter, M. Kendziorek, and D.R. Nysewander. 1990. Immediate impact of the T/V *Exxon Valdez* oil spill on marine birds. Auk 107:387-397.

Sanger, G.A. and M.B. Cody. Survey of pigeon guillemot colonies in Prince William Sound, Alaska. Unpublished report, U.S. Fish and Wildlife Service, Anchorage, AK.

Vermeer, K., K.H. Morgan and G.E.J. Smith. 1993. Colony attendance of pigeon guillemots as related to tide height and time of day. Colonial Waterbirds 16:1-8.

2000 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel	$0.0	$5.7
Travel	$0.0	$5.2
Contractual	$0.0	$33.3
Commodities	$0.0	$0.0
Equipment	$0.0	$0.0
Subtotal	$0.0	$44.2
General Administration	$0.0	$3.2
Project Total	$0.0	$47.4
Full-time Equivalents (FTE)	0.0	0.2
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
Estimated FY 2000	Estimated FY 2001				
$47.4	$10.0				

Dollar amounts are shown in thousands of dollars.

Comments: There budget is the worse case scenario. The is a possibility that NPS or FWS will be able to pay for some of the vessel charter cost, if the vessel will be in the area for normal agency functions. The best case scenario would be that the Trustee Council would need to fund only 4 days (reducing the overall cost of this project by 16.6 k. At this point, we need to ask for the full amount, but if vessel days are available to contribute to this project, the excess funds will be returned to the Trustee Council.

The proposed FY 00 budget includes costs of logistics, data collection, and data summaries during summer 2000. Funds for preparation of the final report (5.7k), preparation of posters (0.5k) to display in Sand Point near the project site, and travel to meetings to present results in January 2001 (2.8) are included in the FY 2001 budget totals.

FY 00

Prepared: 03/31/99

Project Number: 00453
Project Title: Monitoring Recovery of Injured Species Following Removal of Introduced Foxes
Agency: DOI-FWS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRU : **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
G. Vernon Byrd	Project Leader (Principal Investigator)	GS13	0.0	5.0	0.0	0.0
Steven Ebbert	Refuge Biologist, Key Person	GS 11	0.0	4.5	0.0	0.0
Judy Alderson	National Park Service (Cooperator)	GS 12	0.0	0.0	0.0	0.0
(To be selected)	Biological Science Tech. (Wildlife)	GS 6	2.0	2.4	0.9	5.7
(To be selected)	Volunteer		0.5	0.0	0.0	0.0
(To be selected)	Volunteer		0.5	0.0	0.0	0.0
C. Berg	Program Manager	GS12	0.5	0.0	0.0	0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		3.5	11.9	0.9	
					Personnel Total	$5.7

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
Travel to Sand Point to conduct field work	0.7	6	2	0.1	4.4
					0.0
Per diem for field crews (per diem for field personnel is calculated at $3.00 per day times 00 person days = $0.0K--this token amount must be paid to all FWS employees & non-SCA volunteers for each day spent in the field.			8	0.1	0.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5.2

FY 00

Prepared: 03/31/99

Project Number: 00___
Project Title: Monitoring Recovery of Injured Species Following Removal of Introduced Foxes
Agency: DOI-FWS

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed FY 2000
Description	
Use of M/V Tiglax @ $4,160/da for 8 days	33.3
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$33.3

Commodities Costs:	Proposed FY 2000
Description	
Field supplies (maps, notebooks, film, boats, rain gear, binoculars, tally counters, office supplies, and other field gear) will be furnished by FWS	0.0
Commodities Total	$0.0

FY 00

Prepared: 03/31/99

Project Number: 00___
Project Title: Monitoring Recovery of Injured Species Following Removal of Introduced Foxes
Agency: DOI-FWS

FORM 3B
Contractual & Commodities
DETAIL

2000 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
Equipment cleaning/repair/service (includes checking, cleaning, repairing & servicing binoculars, cameras, rafts, radios, outboard motors, survival suits, emergency locator beacons) supplied by FWS			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
Inflatable raft	3	FWS
Outboard motors	3	FWS
Hand-held VHF radios	3	FWS
Camera	3	FWS
Computer	1	FWS
Binoculars	6	FWS
Office space, supplies, and equipment (e.g., computers) will be supplied by the FWS	0	FWS
[Note: FWS will also supply other items, including, including 6 survival suits, & 6 Mustang suits.]		

FY 00

Prepared: 03/31/99

Project Number: 00___
Project Title: Monitoring Recovery of Injured Species Following Removal of Introduced Foxes
Agency: DOI-FWS

FORM 3B
Equipment
DETAIL

Pink Salmon Recovery: Evidence and Consequences of Persistent Oil Contamination in Pink Salmon Natal Habitats

Project Number:	00454
Restoration Category:	Research
Proposer:	Stanley Rice, Ron Heintz, Mike Murphy, Mark Carls NMFS Auke Bay Laboratory ABL Program Manager: Dr. Stan Rice NOAA Project Manager: Bruce Wright
Lead Trustee Agency:	NOAA
Cooperating Agencies:	-
Alaska SeaLife Center:	-
Duration:	2 years
Cost FY00:	$310.5k
Cost FY01:	$104.1k
Geographic Area:	Prince William Sound, and Little Port Walter on Baranof Island (Southeast Alaska)
Injured Resource:	Pink salmon

ABSTRACT

Determination of pink salmon recovery in Prince William Sound (PWS) a decade after the *Exxon Valdez* oil spill remains problematic and controversial. As a whole, healthy population levels have been evident for some time, yet there are reports of persistent oil contamination in natal pink salmon streams, and adverse biological effects at parts per billion oil concentrations, thus this contamination may be inhibiting recovery of wild stocks. Therefore we propose three specific research themes: (1) examination of the natal habitat of pink salmon in PWS for evidence of oil contamination in eggs and spawning redds, (2) measurement of cytochrome P4501A in field and laboratory exposed alevins to relate induction with biological consequences on growth and survival following PAH exposure, and (3) a synthesis of these results with past research and a reexamination of the recovery status of pink salmon and their spawning habitat. A combination of field and laboratory studies will be conducted for one year to complete the pink

salmon toxicity story. Persistent oil reservoirs adjacent to natal streams will be reexamined (last examined in 1995) for evidence of habitat recovery, and the hypothetical mechanism of hydrocarbon introduction into the streams (transfer of dissolved oil in pore water) will be quantified by use of collectors (SPMDs) buried in spawning habitat. Because transient, low level hydrocarbon contamination is difficult to quantify, the biomarker cytochrome P4501A will be measured in eggs and alevins from field and controlled laboratory exposures. Also of great importance, the significance of the biomarker will be determined in measurements of marine growth and survival, using fish from brood year 98 tests underway. A synthesis of these data will help to determine if wild pink salmon in PWS continue to be contaminated by EVO, or if they and their habitat have recovered.

INTRODUCTION

The recovery status of pink salmon in Prince William Sound (PWS) is problematic, because population levels as a whole are relatively high and include fish from large areas with little or no oil-exposure history), while the banks of specific natal streams remain contaminated with oil (Murphy et al. In press). Part per billion sensitivities to oil have been documented in early life stages (Heintz et al. 1999), and elevated egg mortalities in oiled streams were reported by ADF&G as late as 1997. Recovery at the stream level is unknown, and the definition of recovery for pink salmon needs to be re-examined. This proposal will "close the loop" on past pink salmon oil toxicity research by examining the status of oil contamination and egg/alevin exposure at oiled benchmark streams. The use of the biomarker P4501A will be used in field and laboratory tests, and the biological significance of the biomarker will be determined in short-term responses (tissue abnormalities), intermediate responses (growth of cultured fish), and in returning adult pink salmon from previous exposures (brood year 1998).

This project is designed to examine the natal habitat of pink salmon in PWS for evidence of exposure to polynuclear aromatic hydrocarbons (PAHs) derived from *Exxon Valdez* oil. It may be difficult to directly measure biologically available PAHs in the natal habitats 10 years after the spill, but given the levels of oil found in 1995 and the recent findings by ADF&G of elevated egg mortalities in oiled streams, we consider it very possible with the proposed detection technology. We will measure PAH in stream bank sediments (detection is highly probable), in stream sediments (not probable), in eggs (possible), and in oil collection devices (SPMD's) buried in the streams sediments (probable). Further, we will look for biological evidence of oil exposure by measuring cytochrome P4501A in emergent alevins from the streams. These measurements will be the first complete set of observations of this kind made in the oil-contaminated streams. The measurement of oil in the stream banks [repeating the Murphy et al. (in press) study] will permit the extension of the habitat contamination recovery model by 4 years. Demonstration of detectable amounts of PAHs in these environments (or their absence) will provide a direct basis for relating earlier field studies to recent laboratory studies aimed at cataloging the effects of incubating in oiled stream environments. In addition, examination of the incubating environments for evidence of contamination will provide the Trustees with a rational basis for evaluating the recovery status of pink salmon at the stream level, rather than be dependent on population levels that include hatchery production and many streams with little or no oil-exposure history.

Biomarkers like P4501A have been used before as biological evidence of oil exposure (e.g., Wiedmer et al. 1996), but the biological significance of induction is seldom known. We propose to measure cytochrome P4501A activity in emergent fry from oil-contaminated streams and compare to measurements of fry with known exposures and known biological consequences. By using fish from graded exposures and following them through the delayed impacts on marine growth, we can ascribe a biological significance (consequence) to the P4501A measurements. Further, by sampling emergent fish from project 99426 in spring 1999, we can correlate marine survival and reproductive fitness to the three exposure doses that will be released to the field (returning as adults in fall 2000). In past laboratory studies, aqueous PAH concentrations as low as 4 ppb induced cytochrome P4501A activity (Marty et al. 1997), and embryo mortality was elevated at 1 ppb (Heintz et al. 1999). However, none of these experiments were designed to

identify a lowest effective concentration (LOEC) for P4501A induction, and these studies did not establish the biological meaning of exposure by relating induction to demonstrable effects. We will relate differing levels of P4501A activity to long-term effects on salmon growth because growth is a relatively inexpensive criterion to measure, and it effectively integrates most of the long-term effects that are likely to be experienced by those fish that survive the exposure period.

Lastly, the definition of pink salmon recovery, relative to habitat contamination and biological consequences will be examined. The project here will synthesize the present study results, along with other concurent and past studies to give a definitive status of pink salmon recovery.

To prevent losing an entire year of study, NMFS will up-front fund the activities required in Aug/Sept of FY 99 to collect eggs and field samples to initiate this project. These activities are needed to fit the biology of the pink salmon.

NEED FOR THE PROJECT

A. Statement of the Problem

The definition of pink salmon recovery in PWS, currently based on broad geographic populations that include fish from hatcheries and streams with little or no oil-exposure history, is not compatible with measurements of persistent oil effects in wild salmon streams. This study will provide field and laboratory evidence of pink salmon exposure in natal streams, where oil impacts have been measured as late as 1997. Interpretation of results will help to determine if wild pink salmon in PWS continue to be contaminated by EVO, or if they have recovered.

This project examines two questions: are the natal habitats of pink salmon still being contaminated by PAHs derived from the *Exxon Valdez*, and can biomarkers index injury as well as identify exposure. The first question derives from three important observations. First, pink salmon mortalities have been shown to increase at aqueous TPAH concentrations as low as 1.0 ppb (Heintz et al. 1999). Second, oiled gravel is still recoverable near several pink salmon streams in the affected sections of PWS, and third, elevated embryo mortality in oil-contaminated streams was identified as late as 1997. These observations suggest that oil from the *Exxon Valdez* may still be injuring pink salmon in contaminated streams. Consequently, pink salmon are only classified as a recovering species, despite apparently healthy escapement levels in the southwestern district. This project seeks to examine the potential for ongoing injury by quantifying the exposure experienced by pink salmon in their natal streams and identifying what sort of injury can be expected from the observed exposure levels.
This project examines the question of continuing exposure in pink salmon streams in three ways. First we propose to measure the availability of PAHs to incubating pink salmon by measuring the levels of contamination in the streambanks, and in interstitial waters. Second, the uptake of PAHs in pink salmon will be evaluated by measuring PAH levels in eyed eggs collected from oiled streams. Finally, fry from oil contaminated streams will be examined for evidence of PAH exposure by measuring cytochrome P4501A activity in their tissues and the biological significance of these exposures will quantified with laboratory studies.

B. Rationale/Link to Restoration

Pink salmon are listed as a recovering species, and before they can be added to the list of recovered species evidence for continued exposure to oil from the *Exxon Valdez* must be considered. The original criterion the Trustees proposed to use for listing the recovery of pink salmon was the absence of demonstrable effects for two complete reproductive cycles. In 1994 through 1996, pink salmon embryos in oiled and unoiled streams had similar mortality rates, suggesting they had recovered. However, since the criterion was established it has become clear that oil can still be found near natal habitats, and that pink salmon embryos are significantly more sensitive to PAHs than previously believed. These factors may explain the elevated embryo mortalities in oiled streams observed in 1997. Thus, the original criterion for recovery should be reconsidered. We propose to ascertain the recovery status by determining if exposures are still taking place and by relating observed exposures to those known to cause injury.

Direct measurement of PAH concentrations in the natal pink salmon environments will demonstrate the plausibility of an exposure mechanism proposed by Heintz et al. (1999), and measurements in pink salmon tissues will demonstrate exposure. The hypothesized exposure mechanism suggests that PAHs leach from oil reservoirs buried in beaches alongside and above the stream channels into salmon redds via interstitial water flow. This mechanism has not been verified in the field and PAH concentrations in pink salmon tissues have not been monitored. Observation of PAH levels in streambank gravels, in interstitial waters, and in pink salmon tissues will provide a demonstration of this mechanism.

The activity of cytochrome P4501A in pre-emergent fry is an alternative method for demonstrating exposure to PAH. Cytochrome P4501A is an important enzyme system used by fish to metabolize PAHs. Elevated cytochrome P4501A activity was identified in fish taken from oiled streams as late as 1991 (Weidmer 1996) indicating exposure occurred despite the absence of detectable PAHs in the streambed gravel (Brannon et al. 1995). Although activity of P4501A was verification that salmon embryos were exposed, the relationship between P4501A induction and injury has not been evaluated. Thus, we propose to examine the relationships between P4501A induction, TPAH exposure concentration, and biological response of salmon embryos under laboratory conditions.

C. Location

Field samples will be collected from the spill zone in PWS and near Cordova. The laboratory phase of this project will take place at Little Port Walter (LPW), a research hatchery operated by NMFS in southeastern Alaska. This laboratory has been the site of many of the Trustee laboratory studies on oil toxicity to pink salmon. The facility at LPW provides easy access to the intertidally spawning pink salmon stock that has been the subject of previous experiments. In addition, the exposure apparatus requires a simulated intertidal environment and such a system is in operation at LPW.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Field collections will depend on chartering vessel and air support. Contaminated pink salmon streams have been identified by local residents. We will continue to provide information to interested public (primarily fishermen) who visit our laboratory.

PROJECT DESIGN

A. Objectives

This project has three main themes, each with specific objectives:

1. Examination of persistent *Exxon Valdez* oil in natal habitats of pink salmon in PWS, and evaluation of current contamination of eggs and alevins.

    1. *Determine how rapidly the incubating environments are recovering*
        1. Measure oil in banks adjacent to bench-mark streams last sampled in 1995 by fast-screening procedures to extend the recovery model past 1995.
    2. *Measure the availability of PAHs in the incubating environment*
        1. Measure oil in stream sediment by gas chromatography and mass spectrometry (GC/MS) to verify there is little or no contaminant directly in the stream.
        2. Measure aqueous oil contamination in salmon redds with buried semipermeable membrane devices (SPMD's) to verify oil transport interstitially to salmon redds.
        3. Verify method sensitivities by measuring oil in a stream with a known natural oil seep.
    3. *Measure exposure of eggs and fry to PAH*
        1. Directly measure oil concentrations in eggs by GC/MS, and compare to concentrations in SPMD's.
        2. Inspect eggs for indirect evidence of exposure to oil using the biomarker cytochrome P4501A as an index of exposure and compare to PAH concentrations in eggs and SPMD's.

2. Examination of the usefulness of the biomarker cytochrome P4501A as a predictor of the biological impacts of oil exposure
    1. *Controlled laboratory test with graded oil doses to establish a dose-response curve at part per billion levels.*
    B. *Influence of exposure level on the prevalence of cytochrome P4501A activity and embryo tissue*
        1. Inspect emergent fry for gross and histological lesions.
        2. Determine P4501A induction in organ tissues.
    C. *Initiation of cytochrome P4501A activity in developing pink salmon*
        1. At one dose, measure P4501A response at four developmental stages to determine the onset of induction.

D. *Relation between cytochrome P4501A activity and short and long-term effects*

1. Relate P4501A induction to growth of experimental fish cultured at LPW (brood year 99) from the graded series of oil exposures.
2. Relate P4501A induction to ocean survival (brood year 98) and reproductive fitness of returning adults to parts per billion exposures from the companion pink salmon toxicity study 99476.

3. Synthesis of this project, and long-term impact data from other projects, to redefine pink salmon recovery in PWS, and provide a status of that recovery.

The first theme provides a basis for testing the hypothesis that pink salmon, incubating in previously oiled streams, continue to be exposed to PAHs derived from the *Exxon Valdez*. Testing this hypothesis entails three major tasks: 1) determine how rapidly oil reservoirs are being depleted by sampling gravel from the deltas of streams identified as benchmarks in 1989 and resampled again in 1995 (Murphy et al. In press); 2) measure the availability of PAHs in the incubating environment by sampling the water flowing through salmon redds for PAHs using semi-permeable membrane devices (SPMDs), and characterizing the PAH levels in gravels alongside, above, and in the stream channels; 3) establish the availability of PAHs to the eggs by measuring PAH concentrations in eyed eggs and activity of cytochrome P4501A in emerging fry. This latter task will be limited to those sites identified with highest risk as determined by fast screening methods. Each of these tasks will be performed in oiled and unoiled streams selected on the basis of their contamination histories. In addition, the sensitivity of these approaches will be examined by duplicating these approaches in a stream outside PWS, but known to contain a natural oil seep. The seep stream will be an "oiled control."

The second theme tests the hypothesis that increasing PAH levels increase the prevalence of cytochrome P4501A activity and result in long-term injury. P4501A has long been known to document exposure, but the biological consequences are unknown. This hypothesis requires a laboratory study designed to determine 1) when cytochrome P4501A activity becomes detectable in developing embryos, 2) how exposure level influences the prevalence of cytochrome P4501A activity in specific tissues, and 3) the relationship of P4501A activity to both short- and long-term biological response. We propose to incubate pink salmon eggs in variety of TPAH concentrations and examine them periodically for evidence of cytochrome P4501A activity. Prevalence is defined as the product of the intensity of staining and occurrence in histologic sections of tissue examined for P4501A activity by immunochemical staining. The first task is required, because the time of onset may be a better predictor of long-term effects than prevalence at emergence. Induction prevalence will be related to the dosing histories to develop a dose-response curve. The relationship between long-term effects and prevalence will be examined by holding fish from the same exposure groups in captivity and examining them for dose related differences in growth rate.

Synthesis of the first two research themes will provide a rational basis for judging whether or not wild pink salmon stocks in PWS have recovered from the *Exxon Valdez* oil spill. The study will determine if pink salmon eggs are currently being exposed to hydrocarbons in oil-contaminated streams, and how quickly these sensitive environments are recovering. In addition, the development of a relationship between cytochrome

P4501A activity and long-term effects will provide a basis for further evaluating the severity of the exposures indicated by P4501A activity in salmon embryos in first two years after the spill.

B. Methods

Theme 1. Examination of persistent *Exxon Valdez* oil in natal habitats of pink salmon in PWS, and evaluation of current contamination of eggs and alevins.

Determine how rapidly the incubating environments are recovering

Gravel samples from each of the 9 oiled index sites identified in Murphy et al. (In press) will be collected using the procedures described in that report. In addition, oil reservoirs identified in 1995 will also be sampled to determine how rapidly they are weathering. All samples will be collected from sites sampled in 1989 and 1995. All the gravel samples will be analyzed by ultraviolet fluorescence, a fast screening procedure that can be used to identify samples with sufficient amounts of oil to warrant more detailed analysis by GC/MS. The fast screening results as well as the more detailed analyses can be compared to similar data collected in 1995. These data will be combined with those reported by Murphy et al (In press) to extend their recovery model.

Measure the availability of PAHs in the incubating environment

Exposure levels in streams contaminated by the *Exxon Valdez* oil spill will be monitored in the 9 streams identified as having the highest embryo mortality rates in 1997, the 3 reference streams with the lowest mortality rates, and 1 stream with a naturally occurring oil seep (Bue et al. 1998). The Katalla slough, located east of the Copper River, has a natural oil seep and is a cataloged anadromous stream bearing pink salmon. The existence of oil in Katalla slough will provide a measure of the sensitivity of our analyses for detecting petrogenic PAHs in interstitial waters and pink salmon tissues.

Sampling protocols applied to each stream will follow the general procedure of Bue et al. (1996). Streams will be divided into four sections based on their position above mean lower low water and sampling transects will be established in each section using maps developed by Bue et al. (1998). Transect locations will coincide with those used in 1997 whenever possible. Personnel with ongoing experience conducting egg-dig transects in PWS will be contract (i.e., the same crew that ADF&G uses).
Sampling will begin prior to the arrival of adult pink salmon in 1999. Gravel samples will be collected from the stream banks 1 m upstream from either end of each transect as well as from the streambed in the center of each transect. In addition, conspicuous oil deposits located above the stream channel will also be sampled opportunistically. Dissolved PAHs will be sampled by burying a pair SPMDs in pits dug into the streambed near the end of each transect and in the middle. One member of each pair will be recovered approximately 45 days later (during egg digs), and the second the approximately 175 days later during the following spring during

emergent fry sampling. The depths of SPMD burial will be similar to the depths of redds constructed by pink salmon.

PAH levels in gravel samples and SPMDs will be determined by gas chromatography and mass spectrometry (GC/MS) using the methods described by Short et al. (1996). Prior to analysis, sediment samples will be fast-screened to determine the concentrations of total petroleum hydrocarbons (PHCs) by ultraviolet fluorescence. Samples with detectable levels of PHCs will be further analyzed by GC/MS. All the SPMDs from transects found to be downstream from gravel samples with detectable PHCs will also be sampled by GC/MS to determine PAH levels. PAH levels in stream bank sediments and streambed gravels will be used to map the distribution of oil in the incubating habitat, while PAH observations collected from SPMDs will be used to examine the transport of PAHs to incubating habitats.

Measure exposure of eggs and fry to PAH

Availability of PAH's to eggs and fry will be measured in two ways, by PAH concentration in egg tissue, and induction of cytochrome P4501A. Uptake of PAH will be measured in eyed eggs and pre-emergent fry sampled along the transects established to deploy the SPMDs. In early October 1999, each transect will be visited to obtain samples of eyed eggs, and establish the density and mortality of developing eggs in the study streams. The procedure will be repeated in March 2000 to obtain a set of pre-emergent fry for analysis of cytochrome P4501A activity. Eyed eggs and pre-emergent fry will be obtained by hydraulic sampling along the established transects using methods described by Pirtle and McCurdy (1977). Preferred samples of eyed eggs and pre-emergent fry will come from locations nearest each of the SPMDs. The eyed eggs will be frozen immediately after collection to be examined for PAHs by GC/MS. Pre-emergent fry will be preserved in formalin in individual cassettes for later processing to determine cytochrome P4501A induction using immunohistochemical staining. Samples will be analyzed blind.

The only samples of eyed eggs and pre-emergent fry to be processed will be those with the greatest likelihood of having detectable PAHs or P4501A induction. Sample sets will be selected on the basis of the analytical results of oil deposits in associated streambank gravel and SPMD samples. Levels of PAH observed in eyed eggs will be used to demonstrate exposure levels and these will be compared with those observed in laboratory studies described by Heintz et al. (1999). The overall distribution of PAHs in the natal habitats as determined by the environmental data will be compared to estimates of embryo mortality along each transect.

Theme 2. Examination of the usefulness of the biomarker cytochrome P4501A as a predictor of the biological impacts of oil exposure

Controlled laboratory test with graded oil doses

Developing pink salmon eggs will be exposed to oil contaminated water using the laboratory methods described in Marty et al. (1997). Approximately 10,000 eggs will be exposed to each of 5 doses, in order to provide sufficient numbers of fry for examining long-term affects on growth.

Procedures used to determine embryo mortality rates and quantify exposure levels will follow previously described methods (Marty et al. 1997).

Influence of exposure level on the prevalence of cytochrome P4501A activity and organ tissue

Emerging fry will be counted, inspected for gross lesions and sampled to examine the presence of cytochrome P4501A activity. Aliquots of 12 fry from each dose will be retained for analysis of cytochrome P4501A induction with immunohistochemical staining. Fry will be retained in individual cassettes in buffered formalin and shipped to UC Davis for processing. Histological sectioning and determination of cytochrome P4501A induction will follow the procedures described in Marty et al. (1997). Sections of preserved fry will be cut to ensure staining of at least the gill, pharynix, kidney, intestine, heart, liver epidermis and yolk sac. Scores for staining intensity and occurrence will be compared by regression to exposure history to determine which tissue or combinations of tissues are the best indicators of exposure level.

Initiation of cytochrome P4501A activity in developing pink salmon

Alevins from the highest exposure level will be sampled monthly to determine when cytochrome P4501A activity is initiated during development.

Relation between cytochrome P4501A activity and long-term effects

Two methods will be used to relate induction of P4501A to long-term biological effects, including marine survival (1998 brood year) and growth of cultured fish (1999 brood year). Marine survival and reproductive fitness of returning adults will be determined for fish in a previous experiment (study number 99476), where the number of oil exposures was limited to two, but P4501A induction will be determined in eyed eggs and emergent fry sampled prior to release (spring 1999).

Experimental fry from the 1999 brood year will be cultured in net pens for 5 months to determine the value of P4501A activity for predicting long-term effects of embryonic exposure to PAHs on marine growth. Fry will be transferred to separate containers depending on their exposure histories and cultured until they are large enough to tag with passive integrated transponder (PIT) tags. Fry transferred to the culture containers will be measured to determine each group's average weight and length. At tagging the length and weight of each individual will be recorded and growth will be calculated as the difference in the logs of the weight at tagging and the group's initial mean weight divided by the number of elapsed days. After tagging, individual growth records for each fish will be developed by periodically sampling the tagged population. Mean growth rates for each exposure group will be compared to their exposure history and the average combined score for intensity and occurrence for cytochrome P4501A activity in the given exposure group at emergence.

C. Cooperating Agencies, Contracts and Other Agency Assistance

Sampler deployment, initial sample collections, hydrocarbon analysis, laboratory exposures and methods development will be provided by NMFS. Sample collection, in PWS will be performed

with a contract with a local vessel using methods developed by ADF&G. Analysis of cytochrome P4501A will be provided by contract with UC Davis.

SCHEDULE

0. Measurable Tasks donated in FY 99

April 1999: Collect emergent fry for P4501A analysis from exposed fish (brood year 98)
August. 1999: Deploy samplers in stream beds, collect gravel samples, set-up laboratory experiment.

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

Fall 1999: Field: collect SPMDs and eyed eggs from streams
Lab: collect eyed eggs to determine onset of P4501A activity.

Winter 99/00 Field: Begin fast-screen analysis of gravels, and GC/MS analysis on SPMDs and eggs.
Lab: Collect alevins for P4501A induction

Spring 2000: Field: Collect fry samples for P4501A and remaining SPMDs from streams.
Lab: Collect final P4501A samples. Evaluate fry surviving exposures. Begin analysis of fry for cytochrome P4501A activity, and growing out fry exposed in laboratory.

Summer 2000 Lab: Tag cultured fry.

[FY01 begins about here]

Fall 2000: Complete GC/MS analysis of remaining samples, and complete analyses of growth.

Winter 2001: Complete data analysis. Begin writing manuscripts.

B. Project Milestones

Summer 1999 Initiate field and laboratory studies

Spring 2000: Complete field study. Continue to grow laboratory fry.

Fall 2000: Complete hydrocarbon analyses

Jan. 2001: Complete laboratory data collection (P4501A activity), complete data analysis, and begin writing manuscripts

Summer 01: Submit manuscripts to journals

Oct 2001 Submit final report.

C Completion Date

Final Report will be submitted on Oct 1, 2001.

PUBLICATIONS AND REPORTS

Final Report

Peer-reviewed manuscripts:

Murphy, M.L. et al. 2001. Hydrocarbon contamination and recovery of pink salmon spawning areas a decade after the *Exxon Valdez* oil spill. Journal unknown.

Carls, M.G. et al. 2001. Persistent exposure of pink salmon to *Exxon Valdez* oil a decade after the spill. Journal unknown.

Marty, G.D. et al. 2001. Developmental appearance of P4501A biomarker in pink salmon eggs and larvae. Journal unknown.

Heintz, R. et al. 2000. Feasibility of using biomarkers to regulate water quality. Journal Unknown.

Heintz, R. et al. 2001. Relation of P4501A biomarker in alevin pink salmon to long-term grow and reproductive fitness. Journal unknown.

Rice, S.D. et al. 2001. Long-term biological and ecosystem recovery for pink salmon after the *Exxon Valdez* oil spill. Journal unknown..

PROFESSIONAL CONFERENCES

No conferences planned in FY 00, travel to 2000 Oil Spill Symposium is included. (Travel to conferences is planned for FY01.)

NORMAL AGENCY MANAGEMENT

This project seeks to determine the recovery status of pink salmon through a cooperative relationship between NMFS and the Trustees. There is no charge for project support costs which include management of the LPW facility and project budget.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The design of this project has been coordinated with the work performed in the past by ADF&G under Restoration 191A, and the work performed by NMFS under 191B and 194. Investigators and agencies will coordinate by sharing data. NOAA/NMFS will coordinate with the Trustees by providing labor requirements and laboratory overhead. This project also coordinates with pink salmon reproductive fitness project 99426 by collecting emergent fry for P4501A analysis (brood year 98).

PROPOSED PRINCIPAL INVESTIGATOR

Name	Dr. Stan Rice
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PRINCIPAL INVESTIGATOR

GS-13 Physiologist - Stanley D. Rice

Received BA (1966) and MA (1968) in Biology from Chico State University, and PhD (1971) in Comparative Physiology from Kent State University. Employed at Auke Bay Fisheries Laboratory since 1971 as a research physiologist, task leader and Habitat Program Manager since 1986. Rice has researched oil effects problems since 1971, and has published over 100 papers, including over 75 on oil effects. Studies have ranged from field to lab tests, behavioral to physiological to biochemical studies, from salmonids to invertebrates to larvae to meiofauna. Rice has conducted and managed soft funded projects since 1974, including the Auke Bay Laboratory *Exxon Valdez* damage assessment studies since 1989. Activities since the oil spill have included leadership and management of up to 10 damage assessment projects, field work in PWS, direct research effort in some studies, establishment of state of the art chemistry labs and analyses in response to the spill, quality assurance procedures in biological-chemical-statistical analyses, establishment of hydrocarbon database management, servicing principal investigators and program managers in NOAA and other agencies with reviews and interpretations, direct input into agency decisions, interaction with other agencies in various ways (logistics coordination, critique experimental designs, interpret observations, etc.), and lead editor of the first Trustee symposium proceedings.

OTHER KEY PERSONNEL

Mark Carls, Ron Heintz, Mike Murphy, and Jeff Short will assist in data collection, analysis, and interpretation. Robert Bradshaw and Mandy Lindeberg will be responsible for culturing fish from winter 1999 through summer 2000.

LITERATURE CITED

Brannon EJ, Moulton LL, Gilbertson LG, Maki AW and Skalski JR. 1995. An assessment of oil spill effects on pink salmon populations following the *Exxon Valdez* oil spill - part 1: early life history. In *Exxon Valdez* Oil Spill: Fate and Effects in Alaskan Waters. *ASTM STP* 1219. American Society for Testing and Materials. Philadelphia, PA, USA. pp 548-584.

Bue, B. G., S. Sharr, S. D. Moffitt, and A. Craig. 1996. Injury to salmon eggs and preemergent fry due to the T/V *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. American Fisheries Society Symposium Number 18.

Craig, A.K., B.G. Bue, and T.M. Willette. 1997. Injury to salmon embryos and preemergent fry in Prince William Sound, *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 96170), Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Anchorage, Alaska.

Heintz, R. A. , M. Wiedmer and S. D. Rice. 1995. Laboratory Evidence for Short and Long-term Damage to Pink Salmon Incubating in Oiled Gravel. Proceedings of the 16th Northeast Pacific Pink and Chum Workshop. Bellingham Wa.

Heintz, R., Short, J. W., Rice, S. D. (1999). Sensitivity of Fish Embryos to Weathered Crude Oil: Part II. Incubating downstream from weathered *Exxon Valdez* crude oil caused increased mortality of pink salmon (*Oncorhynchus gorbuscha*) embryos . Env. Tox. And Chem. 18(3):494-503.

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Murphy, M. L., Heintz, R. A., Short, J. W., Larsen, M. L., Rice, S. D. (In press). Recovery of pink salmon spawning areas after the *Exxon Valdez* oil spill. Trans. Am. Fish. Soc.

Pirtle, R. B, and McCurdy, M. L. 1977. Prince William Sound general districts 1976 pink and chum salmon aerial and ground escapement surveys and consequent brood year egg

deposition and preemergent fry index programs. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 9, Juneau, Alaska.

Short JW, Jackson TJ, Larsen ML, and Wade TL. 1996. Analytical methods used for the analysis of hydrocarbons in crude oil, tissues, sediments, and seawater collected for the natural resources damage assessment of the Exxon Valdez oil spill. *Proceedings,* Exxon Valdez Oil Spill Symposium. Anchorage, AK, USA, February 2-5, 1993. pp 140-148.

Wiedmer, M, Fink, M. J., Stegeman, J. J., Smolowitz, R., Marty, G. D., and Hinton, D. E. 1996. Cytochrome P-450 induction and histopathology in preemergent pink salmon from oiled spawning sites in Prince William Sound. *In* S.D. Rice, R.B. Spies, D.A. Wolfe, and B. A. Wright (Eds.). *Exxon Valdez* Oil Spill Symposium Proceedings. American Fisheries Society Symposium Number 18.

Appendix:
Sample design

1. Examination of persistent *Exxon Valdez* oil in natal habitats of pink salmon in PWS, and evaluation of current contamination of eggs and alevins.

1. *Determine how rapidly the incubating environments are recovering*
    1. Measure oil in banks adjacent to bench-mark streams last sampled in 1995 by fast-screening procedures.

        oiled: 9 oiled streams * 4 transects/stream * 2 samples/transect = 72
        + 4 mapped locations/ stream * 7 oiled streams = 28
        total oiled = 100 UVF samples
        reference: 3 reference streams * 4 transects/stream * 2 samples/transect = 24
        Combined total = 124 UVF samples.
        All UVF samples will be collected on a single trip - i.e., the effort will not be duplicated later. (The 2 samples from each transect will consist of bank sediments at each end of the transect.

2. *Measure the availability of PAHs in the incubating environment*
    1. Measure oil in stream beds by gas chromatography and mass spectrometry (GC/MS).

        oiled: 9 oiled streams * 4 transects/stream * 1 sample/transect = 36
        reference: 3 reference streams * 4 transects/stream * 1 sample/transect = 12
        Combined total = 48 GC/MS samples. Assume a maximum of 40 samples will require processing. These GC/MS samples will be collected from the central stream channel - i.e., roughly in the center of each transect. (Purpose - demonstrate lack of PAH in gravel despite presence in aqueous form and in eggs.)

    2. Measure aqueous oil contamination in salmon redds with buried semipermeable membrane devices (SPMD's).

        oiled: 9 oiled streams * 4 transects/stream * 2 SPMD/transect = 72
        reference: 3 reference streams * 4 transects/stream * 2 SPMD/transect = 24
        Combined total = 96 SPMD samples.
        SPMD's will be located in pairs in stream channels. The first of each pair will be retrieved after 45 d, the second after about 175 d.

    3. Verify method sensitivities by measuring oil in a stream with a known natural oil seep.

        Gravel: 1 stream * 4 transects/stream * 3 samples/transect = 12 UVF samples
        Gravel: 1 stream * 3 verification samples/stream = 3 GC/MS samples

Water: 1 stream * 4 transects/stream * 1 SPMD/transect = 4 SPMD samples

3. *Measure exposure of eggs and fry to PAH*
   1. Directly measure oil concentrations in eggs by GC/MS.

      oiled: 9 oiled streams * 4 transects/stream * 1 sample/transect = 36
      reference: 3 unoiled streams * 4 transects/stream * 1 sample/transect = 12
      Combined total = 48 GC/MS samples. Assume that no more than 28 samples will require analysis, based on SPMD analysis.

   2. Inspect eggs for indirect evidence of exposure to oil using the biomarker cytochrome P4501A as an index of exposure.

      oiled: 9 oiled streams * 4 transects/stream * 6 fry/transect
      reference: 3 unoiled streams * 4 transects/stream * 6 fry/transect
      Combined total = 360 histo samples collected. Assume a maximum of 124 samples will require processing, based on SPMD and GC/MS analysis. The number of possible analyses could be increased or decreased depending on requirements of the seep stream and the laboratory study.

C' Measure exposure of eggs and fry to PAH in seep stream
   1. Directly measure oil concentrations in eggs by GC/MS.

      1 stream * 4 transects/stream * 1 sample/transect = 4 GC/MS samples. Assume all 4 samples will require GC/MS analysis, based on SPMD results

   2. Inspect eggs for indirect evidence of exposure to oil using the biomarker cytochrome P4501A as an index of exposure.

      1 stream * 4 transects/stream * 6 fry/transect = 24 histology samples.

2. Examination of the usefulness of the biomarker cytochrome P4501A as a predictor of the biological impacts of oil exposure

A. *Controlled laboratory test with graded oil doses: samples required for experimental monitoring and parallelism with field component*

   1. Measure oil in dosing apparatus and in treatment water

      Gravel samples from dosing apparatus: 5 doses * 3 replicates/dose * 2 sample times (beginning & end of dose) = 30 GC/MS samples.

      Treatment water: 5 doses * 3 replicates/dose * 3 sample times (beginning, eyeing, & emergence) = 45 GC/MS samples

No SPMD samples.

2. Measure oil in eggs at eyeing

5 doses * 3 replicates/dose * 2 observations/replicate, where observations are at eyeing and emergence, + 4 (monthly) samples * 3 replicates at the highest dose = 42 GC/MS samples

B. *Influence of exposure level on the prevalence of cytochrome P4501A activity and embryo tissue*

1. Inspect emergent fry for gross and histological lesions.

dose series: 5 doses * 6 fry/dose * 2 life stage (eyeing, emergence) = 60
Combined total = 60 histology samples.

2. Determine P4501A induction in organ tissues.

The previously collected samples collected (step 1 immediately above) will also be processed for P4501A induction.

C. *Initiation of cytochrome P4501A activity in developing pink salmon*

1. At one dose, measure P4501A response at four developmental stages to determine the onset of induction.

Time series at 1 dose: 1 dose * 6 fry/dose * 4 life stages (including eyeing, ... emergence) = 24 induction samples, also to be processed for gross & histological lesions.

4. *Relation between cytochrome P4501A activity and short and long-term effects*

1. Relate P4501A induction to growth of experimental fish cultured at LPW (brood year 99).

No chemical sampling required.

2. Relate P4501A induction to ocean survival (brood year 98).

Activities are handled in project 99476.

Budget Category:	Authorized FFY 1999	Proposed FFY 2000						
Personnel	$0.0	$134.3						
Travel	$0.0	$4.8						
Contractual	$0.0	$132.0						
Commodities	$0.0	$8.1						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$279.2	Estimated FFY 2001	Estimated FFY 2002	Estimated FFY 2003	Estimated FFY 2004	Estimated FFY 2005	Estimated FFY 2006
General Administration	$0.0	$29.4						
Project Total	$0.0	$308.6	$104.1					
	$0.0							
Full-time Equivalents (FTE)	$0.0	1.9						
	Dollar amounts are shown in thousands of dollars.							
Other Resources		$53.0	$0.0					

NOAA Contribution:

Program Manager, Stan Rice 1.0 mo@ 12.2K, Senior Chemist Jeff Short 1 mo @9.4, Fishery Biologist Ron Heintz 1.5 mo@ 10.9K, Robert Bradshaw 1.0 mo@5.8K and Mike Murphy for 2 mo@ 15K for a total NOAA contribution of 53K

FY00

Prepared:4/13/99

Project Number: 00_454
Project Title: Evidence & Consequences of Persistent Oil Contamination in Pink Salmon Natal Habitats
Agency: National Oceanic & Atmospheric Administration

FORM 3A
AGENCY
PROJECT
DETAIL

Personnel Costs:			GS/Range/	Months	Monthly		Proposed	
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1999	
	Ron Heintz	Fishery Biologist	12	0.0	7,386		0.0	
	Mike Murphy	Fishery Biologist	12	1.0	7,575		7.6	
	Mark Carls	Fishery Biologist	12/6	1.0	7,798		7.8	
	Dr. Stan Rice	Program Manager	14	0.0	12,205		0.0	
	Robert Bradshaw	Fishery Biologist	11	6.0	6,162		37.0	
	Mandy Lindeberg	Fishery Biologist	9/2	7.0	4,700		35.2	35.25
	chem-lab labor							
	Holland	Chemist	11	1.0	6,693		6.7	
	Larsen	Chemist	11	1.0	6,693		6.7	
	Lunasin	Chemist	9	6.0	5,558		33.3	
		Subtotal		23.0	64,770	0		
Those costs associated with program management should be indicated by placement of an *.						**Personnel Total**	$134.3	

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 2000
	field sampling, trips to Cordova	370	7	28	6	2.8
	Trustee symposium, Anchorage	450	2	6	150	1.8
	registration, 2 * 100					0.2
						0.0
Those costs associated with program management should be indicated by placement of an *.					**Travel Total**	$4.8

FY00

Project Number: 00___
Project Title: Evidence & Consequences of Persistent Oil Contamination in Pink Salmon Natal Habitats
Agency: National Oceanic & Atmospheric Administration

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:			Proposed
Description			FFY 1999
	Dr. Gary Marty	49967	50.0
	spmd, initial processing	6000	6.0
	chem lab sample processing ABL	19269	19.3
	labor:		
	pre-eye picking	3600	3.6
	emergence	7200	7.2
	tagging	0	0.0
	air charter	15880	15.9
	vessel charter	30000	30.0
When a non-trustee organization is used, the form 4A is required.		**Contractual Total**	$132.0

Commodities Costs:		Proposed
Description		FFY 2000
	8080	8.1
	Commodities Total	$8.1

FY00

Project Number: 00___
Project Title: Evidence & Consequences of Persistent Oil Contamination in Pink Salmon Natal Habitats
Agency: National Oceanic & Atmospheric Administration

FORM 3B
Contractual & Commodities DETAIL

Prepared:4/13/99

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1999
			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
LPW hatchery	1	NOAA
pit detectors	1	NOAA
ABL chem lab	1	NOAA

Prepared:4/13/99

FY00

Project Number: 00___
Project Title: Evidence & Consequences of Persistent Oil Contamination in Pink Salmon Natal Habitats
Agency: National Oceanic & Atmospheric Administration

FORM 3B
Equipment
DETAIL

An Evaluation of the Data System for

The EVOS Long Term Monitoring Program

Submitted under the BAA

Project Number:	00455-BAA
Restoration Category:	Long-term monitoring and research
Proposer:	Charles Falkenberg
Lead Trustee Agency:	
Cooperating Agencies:	ADNR
Alaska SeaLife Center:	No
Duration:	1st year, 1-year project
Cost FY 00:	$64,600
Geographic Area:	No fieldwork
Injured Resource:	

ABSTRACT

We are proposing a pilot project to investigate the issues relating to the creation of the data delivery system needed by the Exxon *Valdez* Oil Spill Trustee Counsel (EVOS) long-term monitoring and research program. In addition to the data collection effort, data delivery will prove to be a critical component of the success of the long-term monitoring and research program. Therefore, as the long term monitoring program is planned, the data delivery issues need to be integrated into that process. We are proposing to outline some of the key data and user issues and provide background research into existing systems that deliver similar data. In addition, we will put forth a strawman proposal for a data system that could meet the needs of the long term monitoring effort.

Introduction

In April of 1997 the Chief Scientist proposed a long-term monitoring and research program as part of the legacy of the Exxon Valdez Oil Spill. Although the details of the monitoring program are still evolving, it will include the collection of data from a variety of sources and the creation of a long-term data archive. The effective use of the data archive by the stakeholders will depend, in no small part on the effectiveness of the data system that will manage that archive and provide access to the data. We are proposing to investigate the issues relating to that data system so that they might be included in the planning of the long-term monitoring and research program. In addition, we will propose a data system that could serve the stakeholders interested in accessing the data that will be collected as part of the long term monitoring program.

The data system will need to provide a variety of users, access to many types of ecosystem data describing the shelf region of the northern Gulf of Alaska. The user community will likely include resource managers, earth system scientists, land use planners, local communities, educators, and other, as yet unidentified stakeholders, as well. It will contain data from the monitoring and research program and possibly include historical and pertinent federal and local data that would be critical to the long term tracking of the coastal ecosystems of Prince William Sound and Lower Cook Inlet.

The successful delivery of the data collected and archived as part of the long-term monitoring program will be key to the long-term effectiveness of the program. Therefore the single goal of building a data system is to provide a vehicle that allows the most cost-effective use of the data collected and maintained by the monitoring program. If the stakeholders cannot find or understand the data and they are not used, the collection effort will have been under-utilized. An effective data delivery system increases the value of the data by increasing the long-term use of those data by the widest number of stakeholders and applications.

Scientific data systems are, however, a rapidly evolving technology. With the advent of the World Wide Web (WWW) many scientific disciplines have made data available to the public and to fellow researchers. Some of these systems have enjoyed the active involvement of members of the discipline and others have been less inspired and less effective. The successful systems have been well planned with a clear set of users and services in mind. We believe, therefore, that these data system issues need to be part of the planning for the long-term monitoring program and that the first step is to examine some other data systems and see how they have succeeded or failed.

We are proposing a small pilot project to investigate the data system issues that need to be considered as the long-term monitoring and research program is brought into focus. We will present the data system issues and the ramifications of some of the choices that will be made in the planning phase of the program. We will use the most current description of the long-term monitoring program as a starting point to estimate the data and user requirements. Using this we will research several other scientific data systems and draw some conclusions about how those systems resolved similar issues. We will

present some of the data system issues that will accompany the data that might be collected and the users that might access them. And finally, we will propose a data system as a strawman that can be used as a reference point as the monitoring program moves forward.

Together, our experience spans many types of data and many existing data systems. We will use our experience with the Sound Ecosystem Assessment (SEA) project database to evaluate the challenges of managing particular datasets. We will also investigate several data system in the space sciences that have grown as both top down and bottom up systems. Finally we will pay particular attention to the variety of current data systems which have GIS and ecosystem data for the northern Gulf of Alaska region including the Cook Inlet Information Management and Monitoring System (CIIMMS) and the Alaska Geographic Data Clearinghouse (AGDC).

Need for the Project

A. Statement of Problem

In his position paper from April 1997 the chief scientist calls for a "permanent, adaptive, interdisciplinary monitoring and research program" designed to carry on a subset of the research and monitoring that has been supported by the Trustee Council. Over its extended lifetime this project will collect and assemble a large volume of biologic and physical data for use by a wide range of stakeholders. The data system that is used by these stakeholders to access these disparate data will be critical to the successful delivery of these data and the overall benefit of the monitoring program. The issues relating to this data system are therefore closely linked to the goals of the long-term monitoring program and need to be included as the program is planned and designed. These issues include the impact of certain types of data and groups of users on the overall design and scope of the data delivery system.

Although the datasets and data sources are under evaluation the following general categories were discussed at the EVOS meeting in 1998:

- Physical data on the climate, hydrology, and oceanography of the region.
- Lower trophic level data on nutrients, and phytoplankton and zooplankton.
- Data on the growth and distribution of the nekton communities.
- Apex predator data, including birds and marine mammals.

The sources of these data are also of great importance to the operation of a data archiving system. Data policies, data format, lag time, and data ingestion may be quite different for different sources. A subset of the possible sources include the following:

- Previous EVOS funded projects and other focused research efforts.
- Repeated measurements made for monitoring purposes.

- Relevant Federal or State data including remotely sensed data and historical data
- Data from external research efforts that would like to utilize the archive facility.
- Results from models which describe or predict any of the relevant variables

Finally, the data system will likely manage two other critical types of data: GIS data, and text documents and reports. GIS data are maintained by several state and federal agencies and are an important component of most regional analysis. These data might be included in the archive or accessed from distributed archives through an interoperability layer. Many of the current scientific data systems are blending geographic data and measured data to provide context for science and enriched geographic analysis.

Published and unpublished text documents are already available electronically in large volumes and this trend will continue. Making final reports available, along with the data, is often the best data documentation possible. In addition, both GIS and text data can be extremely useful in finding relevant data. Data are often requested using specific geographic features, and if datasets are linked to electronic reports, full text search can be used to locate datasets of interest.

While the types and sources of data effect the operation and structure of the data system, the selection of groups that the long-term monitoring program intends to support will effect the functionality of data system. Although this targeted user community is also being defined, the current estimate includes:

- Earth system scientists who are analyzing the long-term trends in the region.
- Land use planners and managers who are granting permits and evaluating the impact of development.
- Applied scientists who support the local and state agencies with regional analysis.
- Local communities and fisherman who have a vested interest in the resources.
- Educators and students at the secondary or college level.
- Industrial stakeholders including Alyeska and the tourist industry.

The user base may or may not include any one of these groups but each one presents a unique set of challenges and requirements for the design of the data delivery system.

Although the combinations of these data types, sources, and user groups present a significant number of challenges, a data system that addresses these issues will be a key component of the success of the monitoring program as a whole. The potential benefit of the data collection effort will only be fully realized if those data are used by the widest number of users and applications. Without a thorough delivery system valuable data will loose its long-term value.

The design and goals of the collection effort will have a significant influence on the design of the data system. In addition, the capabilities of the data system will determine who uses it and how it is used and therefore impact the collection effort in the long run. Finally, the data submission policies, including when and how data is supplied to the archive, need to be part of the RFP process and these policies need to be based on the design and goals of the data system that will support the archive.

B. Rationale

Effective planning for the data system should begin with clarifying goals of the system and reviewing the prior work done in this area. As those goals are set, the significance of each needs to be understood and supported with background research. Planning the complete data system includes an analysis of the data supply and user demand, as well as the available technology that might be utilized, but our rational is to start small. The planning can begin with small steps that will help clarify the goals and the ramifications of setting those goals. One of the first steps is to frame the initial issues and consider design and success of similar data delivery systems. The next step is to estimate the funding that might be available to develop and maintain a data system in order to constrain the design and form a reasonable set of expectations.

We are proposing to conduct this background research and combine it with our EVOS related data collection and archiving experience into a final report of data system issues. These include questions about the user community, the data types and sources and the long-term administration of the archive. Once this is completed we will make an estimate of funding and outline a data system that can be used as a stawman as the monitoring system takes shape.

As an example of the data issues, data on specific species that has been collected or recorded by hand may have a rich structure but it may include many errors related to manual entry. These data require additional effort as they are added to the database even though the volume can be quite manageable. On the other hand, measured data from remote or in situ instruments can be quite voluminous with errors that tend to be more systematic in nature. These data may require additional meta-data and place special demands on disk capacity. In addition, similar data from different sources may be recorded with different levels of precision and may be submitted to the archive in different units and formats. The ability of the monitoring program to establish the desired formats will depend entirely on the data source. Monitoring efforts may be funded to produce data in a specific format but the researcher may define the format of the results from historic or ad hoc research.

The functionality of the system depends on the intended user community. Ecosystem and earth system scientists may want raw data along with complete documentation as to how, when, and where those data were collected. Resource managers on the other hand, are interested in some standard data products that can be used on a regular basis to evaluate he impact of ongoing management policies. Both groups may be interested in some level of on line analysis and GIS integration but the specifics are likely to be quite different.

The scientific community has developed a wide variety of data systems that address these problems to a lesser or greater degree. These include systems built by NASA, NOAA and NSF to display and distribute a wide range of data. NASA distributes both earth and space science data on a large scale and has funded a number of interesting centralized and grass roots data systems. NOAA maintains archives for fisheries and oceanographic data and has also funded several data systems. NSF has supported the Long Term Ecosystem

Research (LTER) program as well as funding and initiative devoted to the issues of digital libraries. Other possible examples might be drawn from EPA, FOCI or Globec.

Unlike many of the federal data systems, the data system for the long-term monitoring program might be distributed in nature. Both scientific and GIS data for the northern Gulf of Alaska are maintained in many different federal, state, and local archives. This suggests that a successful data system could provide pointers to relevant data in similar archives and not replicate data. However, on a long-term scale our current data will become historic data and some of the distributed data may need to be saved in order to provide proper context and the EVOS data archive might be the only place that can provide a safe data haven.

C. Location

Since this is a data system related project it is not tied to any particular region of the northern Gulf of Alaska. The work will be conducted at the DC offices of ECOlogic Corp. and at the EVOS meeting or ad hoc meetings in Anchorage.

Project Design

A. Objectives

We will produce a report containing the results of our investigation that includes our combined experience in building and evaluating scientific and spatial data systems for the northern Gulf of Alaska. We will be estimating which data or users the long-term monitoring program will include and presenting the data system issues that will accompany those choices. Our report will include but may not be limited to the following topics:

- **Data types and Sources and the related issues.** These issues include data complexity and volume, policies for collection and submission, ingestion requirements, other sites with similar data, and data formats and interoperability.
- **Possible user groups and requirements.** User requirements can vary greatly and we will present some of the needs of specific user groups. These include datasets and regions of interest, data download or analysis requirements, and processing requirements during data delivery.
- **Other state and federal data archives.** We will review several existing archives and data systems and the ways in which these systems dealt with the challenges we have outlined.
- **Other Alaskan and EVOS related archives.** We will look at some of the existing efforts to archive ecosystem data for the State of Alaska including CIIMMS and the Alaska Geographic Data Clearinghouse.

Secondary topics will include:

- **Potential functionality of data system.** The functionality can range from simple download of raw data to comprehensive query, visualization and analysis. We will discuss this range and use the existing data system examples.
- **Long-term archive administration.** The long-term administration will include the operational facilities and personnel required to maintain the system over its lifetime.
- **Software and hardware questions.** We will present some of the software and hardware issues including existing commercial software that may be available for particular types of data (e.g. GIS data)

B. Methods

We will start from the current discussion of the long-term archive and estimate the data types and sources which could be involved. In addition, this will provide insight into the likely or intended user community. We review several existing data systems and present a taxonomy in which they can be classified and discuss the technical requirements for the different types of systems. Finally, we will estimate the funding level for a data system, propose a strawman system, and describe an organization that would be needed to support it.

Data and user estimates

Drawing on our experience with other EVOS projects and with non-EVOS data systems we will outline the issues that are associated with the data types and sources. In addition, we will describe the user groups and the framework in which they would best be able to utilize the data from the long-term monitoring and research program. From this point we will research existing data systems inside and outside the state of Alaska.

Data system review

We will first look at the Long Term Ecological Research (LTER) archives that are funded by the National Science Foundation. This project is committed to long-term research and archiving and may provide a valuable reference point for another long-term archive. NASA and NOAA have also implemented several scientific data archives that will be useful. The NASA EOS program is focused on the problems of a large volume of remote sensing data but it may still have some relevance. In addition, NASA has overseen the development of several grass roots data systems including the Space Physics Data System (SPDS) and the Planetary Data System (PDS). These may both provide interesting examples of successful data systems, built by and for scientists. NOAA has several data archives including the National Oceanographic Data Center (NODC) and fisheries archives for the National Marine Fisheries Service (NMFS). These may provide good examples of relevant scientific archives as well as potential sources of data.

Other possible data archives include the Globec and FOCI projects, EPA funded environmental archives, and atmospheric and meteorological archives. Finally, an effort spawned by NSF has been researching the requirements of digital libraries. The Alexandria Digital library focuses on spatial data in digital form and will be a useful

example. As this aspect of the project unfolds, several other potential scientific archives will likely emerge and may be included in the investigation.

We will also examine the current state and use of the existing databases that maintain data on the northern Gulf of Alaska. Some of these will be EVOS funded projects including SEA, Apex and the hydrocarbon database. In addition, the Alaska Department of Natural Resources is building CIIMMS and we intend to place a special focus on this system.

Many of the regional archives include GIS data and text. We will examine how these data type in specific are being managed and how they might be incorporated into the data system for long-term monitoring program. Some of this perspective will come from systems that manage other large scientific archives in conjunction with GIS data.

Proposed system

Any proposed system will be based upon an estimate of funding available. Although this level of funding has not been established, we will propose a funding level based upon the amount of the budget that could be allocated to the data collection effort. Using this as a starting point we will present a data system that can be used as a strawman during the ongoing discussions and planning meetings. The hardware and software options and the personnel and management options will be included as well.

The design and staffing for the data system will be based on an assumption of how and when the data will pass from the data suppliers to the archive. Understanding the life cycle of the each dataset and the stages through which each file in that dataset will pass, can have a significant impact on the data submission guidelines that the monitoring program may require. Once a framework for the data system is accepted, guidelines for how data should be formatted and when is should be submitted to the archive can be drawn up and made part of the RFP process.

C. Cooperating Agencies and Groups

The project will be led by Charles Falkenberg from ECOlogic Corp. and include collaborators from the Advanced Visualization Lab at the University of Maryland and the Alaska Department of Natural Resources. The individuals from these groups bring a unique perspective to this project and their responsibilities are described in the section entitled "key personnel" and included in the attached letters of support.

Schedule

A. Measurable tasks for FY00 (Oct 1 1999 – Sept 30, 2000)

December 31:	Complete plan for background research
January 18 or 28:	Attend EVOS annual meeting. Meet with ADNR.
July 30:	Complete final report of data system issues and background.

B. Project milestones

We expect our effort will require about 5 person months of research, analysis and report writing. In that time we will be reviewing the existing systems, contacting individuals who can provide insight into particular data systems, and writing up the report. The report will be intended for the planners of the long-term monitoring and research program with the hope of adding insight to the planning process.

The research and analysis will be conducted on either side of the annual EVOS meeting in January 2000. The initial work will be done before the meeting and we will use that meeting as an opportunity for the collaborators to evaluate the research and outline the report. Any additional research will be done after the Symposium and final report will be produced by the end of July.

Reports

The final report for this project will include the results of our background research and the issues related to the data system for the long-term monitoring program.

Principal Investigator

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Charles Falkenberg has an MS in computer science and has been involved in building database systems since 1980. He was the principal developer of the archive and data system for the EVOS Sound Ecosystem Assessment (SEA) project. He has 20 years experience designing and building database systems and has worked for the last 6 years on several different scientific data systems. These included data management systems for hydrologic data, oceanographic data, NASA's Earth Observing System (EOS) data, and data environmental assessment at a local and national level. ECOlogic Corp. is a software development and consulting firm, specializing in spatial data management for science and industry. It is currently working on three NASA projects developing tools and applications for EOS data archiving and analysis.

Other Key Personnel

Ravi Kulkarni developed the CDF scientific data format and has been involved with both space science data systems and visualization. He is currently working on a NASA project that is exploring techniques for standardizing the process of data publication. He will evaluate several of NASA grass roots data systems and provide an analysis of potential data publishing techniques. In addition, he will assist in developing the data system taxonomy and in the preparation of the final report

Carol Fries is a Natural Resource Manager in the Office of Commissioner, EVOS at the Alaska Department of Natural Resources and has been involved in organizing the EVOS CD and GIS data for the EVOS region. ADNR is currently implementing the Cook Inlet Information Management and Monitoring System. This system is still in the formative stages but could be a clearinghouse of clearinghouses providing a central location for national and regional data related to Cook Inlet and the watersheds that feed it. The CIIMMS project is headed up by Kelly Zeiner who, along with Carol, will provide insight into CIIMMS and a perspective on the GIS data that need to be accessed as well as wide variety of data that been collected as part of ongoing EVOS research.

Vince Patrick is a founding member of the SEA project and is the principal investigator for the SEA modeling effort as well as the SEA database. He has been involved with the data issues in SEA and brings a deep understanding of the challenges of ecosystem analysis. Although not directly involved with this project Vince will be available to

review the report and comment on the demands that ecosystem modelers place on a scientific data management system.

2000 EXXON VALDEZ TRI _ E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$52.3
Travel		$1.5
Contractual		$0.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$53.8
Indirect 20%		$10.8
Project Total	$0.0	$64.6
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:
Direct cost include salary and benifits
Indirect costs include General and Adminstrative expenses

FY00

Prepared: 12-Apr-99

Project Number: 00455-BAA
Project Title: An Evaluation of the Data System for the EVOS Long Term Monitoring Program
Name: Charles Falkenberg

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
	Charles Falkenberg	Principal Investigator	4.5	9.5		42.8
	Ravi Kulkarni	Co-Investigator	1.0	9.5		9.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	5.5	19.0	0.0	
					Personnel Total	$52.3

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2000
	EVOS Annual Meeting Plane fare and hotel charges	1.0	1	5	0.1	1.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$1.5

FY00

Project Number:
Project Title: An Evaluation of the Data System for the EVOS Long Term Monitoring Program
Name: Charles Falkenberg

FORM 4B
Personnel & Travel DETAIL

epared: 12-Apr-99

2000 EXXON VALDEZ TRUSTEE 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	
Commodities Total	$0.0

FY00

Prepared: 12-Apr-99

Project Number:
Project Title: An Evaluation of the Data System for the EVOS Long Term Monitoring Program
Name: Charles Falkenberg

FORM 4B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRUSTEE 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:
Project Title: An Evaluation of the Data System for the EVOS Long Term Monitoring Program
Name:

FORM 4B Equipment DETAIL

epared: 12-Apr-99

Comparison of Three Techniques For Estimating Fish Population Diversity, Abundance, and Size Structure.

Project Number:	~~00XXX~~ 00458
Restoration Category:	Research
Proposer:	USFS
Lead Trustee Agency:	USFS
Cooperative Agencies:	None
Alaska Sea Life Center:	No
Duration:	1 year
Cost FY 00:	$15.8
Geography Area:	Prince William Sound
Injured Resource/ Service:	Cutthroat Trout and Dolly Varden

ABSTRACT

Cutthroat trout (*Onchorhynchus clarki*) and Dolly Varden (*Salvelinus malma*) are currently listed as resources injured from the *Exxon Valdez* Oil Spill (EVOS) and their recovery is unknown. Significant gaps in knowledge exist regarding the distribution and abundance of these species, particularly in western Prince William Sound (PWS). Populations tend to be small and relatively isolated from each other. Although commonly used methods work well for determining presence and absence of species, little is known regarding the bias associated with each method for determining size structure and abundance for cutthroat trout and Dolly Varden in PWS. In this study, we will evaluate minnow trapping, snorkeling and electrofishing techniques for determining species richness (number of species), abundance (number of individuals) and size structure (age class). These results will assist managers in EVOS projects as well as other future restoration and conservation efforts.

INTRODUCTION

Studies carried out after the *Exxon Valdez* Oil Spill (EVOS) suggested cutthroat trout and Dolly Varden populations may have been adversely affected in Prince William Sound (PWS). Most cutthroat trout populations are small and may be especially sensitive to environmental impacts (Hodges and Buckley, 1995). Coastal cutthroat trout represent the northern and western most extremes of their range in North America (Hickman and Raleigh, 1982). The *Exxon Valdez* Oil Spill Trustee Council lists coastal cutthroat trout as an injured resource whose recovery is unknown. However, determining injury and recovery is difficult, given that even a basic understanding of the species distribution and abundance is unknown.

The purpose of this study is to compare commonly used sampling methods to determine the accuracy and efficiency of minnow trapping and snorkeling against electrofishing techniques. The results will provide managers with a tool to monitor populations of cutthroat trout and Dolly Varden in the future. The proposed inventory project (00383) for investigating cutthroat trout and Dolly Varden populations can use results from this study to efficiently evaluate streams of PWS. Data from this study may also be integrated with results from EVOS project 97302 (Inventory of cutthroat trout and Dolly Varden in PWS). Additionally, results from this study will provide an essential tool needed for the continual management of coastal fish populations.

NEED FOR THE PROJECT

A. Statement of Problem

In order to effectively manage cutthroat trout and Dolly Varden populations in PWS, other aspects of population biology need to be understood. With the construction of the Whittier road, the number of angler days are predicted to increase from an average of 9,800 days to 81,750 days in the year 2015 (Alaska Department of Transportation and Public Facilities 1995). Anadromous cutthroat trout are highly susceptible to over harvest (Gresswell and Harding 1997) and it is likely that they will be a highly sought after recreational resource because of limited opportunities to catch cutthroat trout elsewhere in north central Alaska. To understand the relative sensitivity, it is imperative to possess knowledge on the abundance and size structures of these populations. Bias for different sampling techniques exists, and how these affect monitoring and investigation studies is not clearly understood.

To date, minnow trapping is the most commonly used technique for sampling streams of western PWS (EVOS 99043B). Preliminary observations suggest that minnow trapping is biased against cutthroat over 125 mm total length. Additionally, it appeared that small cutthroat were less likely to enter traps if they were filled with coho salmon (*Oncorhynchus kisutch*). He and Lodge (1988) reported trap avoidance by mudminnows (*Umbra limi*) when traps contained predator species such as redbelly dace (*Phoxinus eos*) and finescale dace (*P. neogaeus*), although mudminnows were responsive to traps once populations of dace were reduced. Coho salmon, when sufficiently large, may prey on cutthroat trout, creating a similar trap avoidance situation (Sabo and Pauley, 1997). If cutthroat trout do exhibit trap avoidance behaviors, previous information on cutthroat trout abundance may be biased.

Snorkeling can also be used to assess the population abundance of cutthroat trout (Bozek and Rahel, 1991) and Dolly Varden. Several factors, including the behavior of fish species and attributes of the physical habitat, can bias the results (Thurow, 1994). Other factors including water temperature and lunar cycle may also influence the accuracy of snorkeling counts (Thurow and Schill, 1996). Rodgers, et al. (1992) suggested that interactions between pool size and fish density might affect the accuracy of snorkel estimates.

Despite these biases, snorkeling can be efficient and have minimal impact to populations. Streams can be surveyed much quicker than minnow trapping or electrofishing (Rodgers et al., 1992). Snorkeling was shown to be nearly as effective as electrofishing for estimating numbers of age one and older juvenile trout (Fraley et al.,1981 and Shepard et al.,1982) and provide a quick, reliable density estimate of westslope cutthroat trout (*O. clarki lewisi*) at a relatively low monetary cost (Zubik, and Fraley, 1988). Snorkeling may prove to be an under utilized, but efficient technique for sampling sensitive fish populations in PWS.

Electrofishing is widely used to estimate fish populations and describe their size structure (Anderson, 1995). For example, this technique yielded larger estimates of abundance of bull trout (*Salvelinus confluentus*) when compared with snorkeling techniques (Thurow and Schill, 1996). Some difficulties with this technique include lower efficiency in high gradient water (Bozek and Rahel, 1991) and for sampling small fish (Anderson, 1995). Many studies have been conducted to determine the extent of injury and trauma to fish (Thompson et al., 1997). Greater body length fish (i.e. adults) had higher mortality in a study by Thompson et al. (1997) and juvenile cutthroat trout lost weight although growth was not affected (Dwyer and White, 1995). However, electrofisher settings and waveforms can be set to minimize all levels of injury without compromising efficiency (Thompson et al., 1997).

Removal sampling has been frequently used for estimating absolute abundance of a fish population (Heimbuch et al., 1997). To use this technique, a portion of the population is removed and the population size is estimated based on the rate of decline in catch per unit effort caused by repeated fishing. In this way, collection efficiency can be quantified with as few as two passes, but the probability of failure increases with a low number of passes (Heimbuch et al., 1997).

B. Rationale/ links to Restoration

Since the oil spill, many efforts have been made to study, restore and enhance known populations (i.e. EVOS 99043B, 97302, 94090, 93106). These studies have focused on habitat enhancement, inventory, survival, and growth of Dolly Varden and cutthroat trout populations in PWS. Despite this extensive research effort, little information is available on the distribution and abundance of cutthroat trout populations in western PWS.

An important emerging issue related to cutthroat trout is the opening of the road to Whittier which is expected to increase use in western PWS by over 600 per cent (Alaska Department of Transportation and Public Facilities 1995). Without baseline knowledge of distribution, population abundance, size structure, and sensitivity to change, these sensitive fish populations could suffer significant effects impairing recovery. With some of the populations thought to number less than 150 individuals, it is imperative for managers to possess this type of information.

This study will help managers understand the bias associated with different sampling techniques in PWS and aid in designing cost effective and precise sampling projects. The results can be applied to other ongoing or proposed projects such as the Cutthroat and Dolly Varden Assessment (EVOS 00383), Growth Rates of Cutthroat Trout and Dolly Varden in Prince William Sound (00XXX), and other monitoring efforts.

C. Location

Minnow trapping, snorkeling and electrofishing studies will occur at reaches two and three of Gunboat Lakes located in western PWS north of Eshamy Bay in PWS, Alaska (Figure 1).

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Whittier provides excellent access to western PWS and the study location. We often talk with individuals from the community and discuss current work projects. Individuals from the community express their concerns and ideas when crews are preparing boats in Whittier. The Glacier Ranger District harbors all boats in the port and fuel, food and incidental supplies are purchased in the town.

There will be meetings in local villages of western PWS, including Whittier, to explain the research effort and to inquire about their knowledge of cutthroat distribution. Research findings from this study will also be verbally addressed in non-technical terms at public meetings.

PROJECT DESIGN

A. Objectives

1. To compare and contrast estimates of species richness, abundance and size structure of fish species present in the streams of PWS obtained from snorkeling, minnow trap and electrofish sampling.

2. To determine potential inaccuracies in current fish sampling techniques in PWS and identify the most precise and efficient sampling technique for Dolly Varden and cutthroat trout.

B. Methods

Sampling will occur in Gunboat Creek which is known to contain cutthroat trout, Dolly Varden, coho salmon, sockeye salmon, and sculpin (Alaska Department of Fish and Game Anadromous Fish Catalog). This system has been surveyed in previous years to determine channel types (USDA, 1992) and habitat availability (Hawkins et al., 1993).

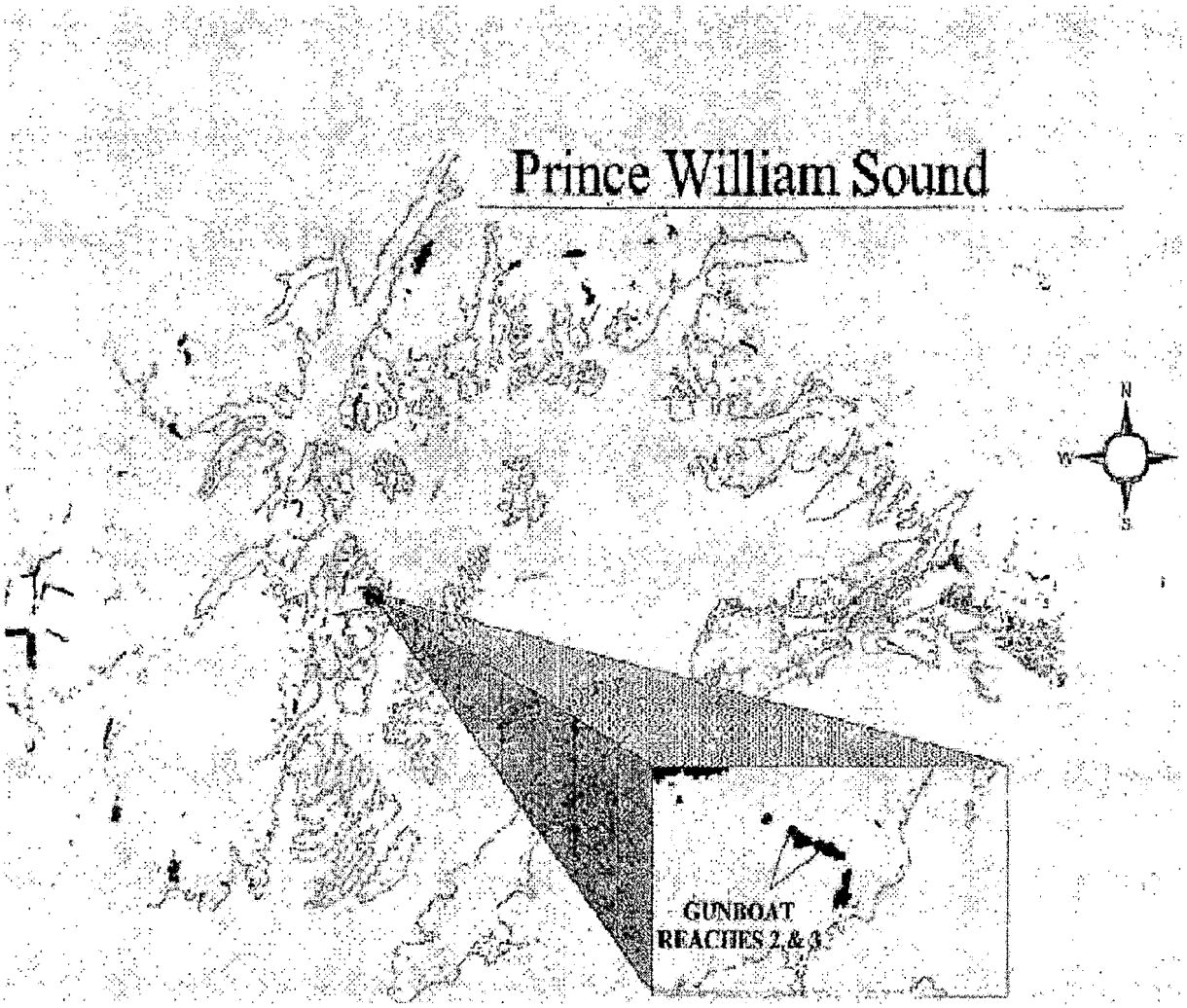

Figure 1. Location of twelve sample sites at Gunboat Streams, Eshamy Bay, PWS. The sample sites are located in reach two and reach three.

To encompass the variability of Gunboat Creek sampling will occur in two reaches (Figure 1). Both reaches vary from one to six per cent gradient and are known to contain all species listed above. Because gradient is thought to affect capture success, we stratified each reach again based on gradient. There will be two sampling sites in each of the two gradient classes (1-3%; 4-6%) for both of the sampled reaches for a total of 8 sampling sites.

Each sampling site will be 30 meters in length and will have similar habitat availability (i.e. pools, riffles). Sites will be blocked off with 1/4 inch mesh and secured to prevent immigration or emigration. The temperature, length, width, conductivity, flow and mean depth will be recorded to ascertain effects on fish behavior. At each sampling site, snorkeling, minnow trapping and electrofishing will occur on different, consecutive days. Minnow trapping and snorkeling will be altered in sequence at all sampling sites. Electrofishing will always occur on the last sampling day at each site.

Prior to the snorkel count, experienced observers will practice estimating fish lengths at a variety of distances. All snorkelers will observe hand held specimens underwater while moving away from the fish. Depending on stream width and visibility, one or two snorkelers will slowly work upstream. For each fish encountered, snorkelers will record the identity and estimated length. Data will be recorded on underwater data sheets with grease pencils. Snorkelers will make three passes and their immersion time will be recorded. The area will be left undisturbed for an hour between passes.

Minnow traps will be baited with betadine-treated eggs (Alaska Department of Fish and Game permit requirement). The upstream entrance will be pinched closed to reduce escapement (Culp and Glozier, 1989). Ten traps will be dispersed evenly within the sampling area (Lorenz, W.R., 1984), approximately every three meters. Each trap will be randomly set left, center or right according to a previously selected random sampling table. Traps will be left in the water to fish for one hour. Captured fish will be anesthetized, identified and measured (recorded to the nearest millimeter). All fish will be kept in buckets until minnow trapping is complete and released after third trapping. The area will be left undisturbed for an hour before retrapping. The process will be repeated two more times. All mortalities will be recorded.

The sample area will be elecrofished three times. After each pass, species will be identified, measured to the nearest millimeter and placed in buckets until electrofishing is completed. Mortalities will be recorded. A Smith Root electrofisher will be used to shock the fish. Electrofisher settings and waveforms will be set to minimize all forms of injury (Thompson and Bergersen, 1997).

Analysis: Following sampling we will evaluate the hypotheses that (1) there is no significant difference between methods for determining species composition, relative abundance and size distribution of fish, (2) there is no significant difference between methods in the two gradient classes, and 3) there is no significant difference between methods in efficiency (time to survey).

To determine if there is a significant difference in sample site population estimates, we will compare the snorkeling and minnow trapping estimates to the electrofishing estimate (the latter considered to be the most accurate estimate). This estimate will be derived from a depletion analysis of electrofishing data. Data will be grouped by fish size and species for each gradient

class. To determine overall differences, comparisons from pooled data from the entire stream will be made by age class and species against the different treatments (techniques). These data will pooled by gradient class and the same comparisons made. Differences between methods for efficiency (time to sample) will be compared using pooled data for the entire stream .

C. Cooperating Agencies, Contracts, and Other Agency Assistance

We will acquire a permit from the ADF&G to conduct this research. Obtaining such permits has not been a problem during previous research projects on cutthroat trout and Dolly Varden.

SCHEDULE

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

October 1- 31:	Visit site. Determine sampling areas. Flag sites with markers. Present project at local village meetings.
November 1- April 30:	Contact ADF&G to obtain permits Arrange logistics. Gather sampling gear.
May 1- 31:	Conduct field work.
July 1- 30:	Conduct field work.
August 1- September 30:	Analyze data and Write final report.

B. Project Milestones and Endpoints

November 1- April 30:	Contact ADF&G to obtain permits Arrange logistics. Gather sampling gear.
May 1- 31:	Conduct field work.
July 1- 30:	Conduct field work.
August 1- September 30:	Analyze data and Write final report.

C. Completion Date

The final report will be provided for peer review in the year 2000.

PUBLICATIONS AND REPORTS

The study will be submitted to a fisheries journal for potential publication as soon as possible.

PROFESSIONAL CONFERENCES

Upon request from the EVOS Trustees Council, the results from this study will be presented at the yearly EVOS meeting. They will also be presented at the annual meeting of the American Fisheries Society (Alaska Chapter).

NORMAL AGENCY MANAGEMENT

Research for determining the accuracy of different sampling techniques is not required by statute or regulation by the USFS. However, this information is valuable in the process of fisheries management. Research studies such as this are generally not funded. There is no known research on the comparison of minnow trapping and snorkeling for cutthroat trout in small streams.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

We will coordinate with ADF&G to review sites before sampling begins in. We will refer to EVOS project 98043 for data acquired from stream surveys. The USFS, Glacier Ranger District, will provide access to the boats and sampling and camping gear.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

No ongoing project.

PROPOSED PRINCIPAL INVESTIGATOR

Robert E. Spangler
U.S. Forest Service
P.O. Box 129
Girdwood, AK 99587
(907) 783-3242
FAX: (907) 783-2094

PRINCIPAL INVESTIGATOR

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, Montana and Alaska.

OTHER KEY PERSONNEL

Elizabeth A. Kitto obtained her B.S. from the University of Pittsburgh at Johnstown and is currently pursuing a M.S. degree at the University of Alaska Anchorage. She has worked for four years in PWS with the USFS and four seasons as an observer in the Berring Sea and Gulf of Alaska for NMFS.

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United States Department of Agriculture | Forest Service | Chugach National Forest | 3301 C Street Suite 300 Anchorage, AK 99503

File Code: 1920

Date: October 8, 1998

Subject: Project re-initiation letter for the revision of the Chugach Land and Resource Management Plan

To: Gary Lehnhausen, Forest Plan revision Interdisciplinary Team Leader

The Notice of Intent to revise the Chugach National Forest Land Management Plan was published in the ***Federal Register*** on April 21, 1997. Since that time a number of personnel changes have occurred that may directly or indirectly affect the roles and responsibilities of the revision interdisciplinary team. Since the initiation of this revision project we have had a change in Forest Supervisor and one of the co-team leaders has left the agency. There have also been changes in responsibility for wildlife and ecology input to the interdisciplinary team. Therefore, I feel a need to provide updated planning direction to redefine the goals and objectives for the revision of our Forest Plan.

The revised Forest Plan should seek to ensure that the Chugach National Forest can continue to provide the values, uses, products, and services society desires now and in the future while yielding high quality habitat for fish and wildlife, clean drinking water for communities, and economic and recreational opportunities for people. Using an "Ecosystem Management" approach to the revision process will help to reconcile the competing and sometimes contradictory values that Americans hold about their natural resources through the application of active management programs. The strategy for accomplishing these objectives should be to provide a broad framework of ecosystem management principles within which District Rangers have the flexibility to make management decisions appropriate for the specific conditiions and needs on each Ranger District.

Purpose and Need

Forest ecosystems change over time and the values that people place on them are also dynamic. The progress of science often leads to the discovery of new information about the relationships within natural environments.

The National Forest Management Act of 1976 anticipated these changes and required Plan revisions every 10 to 15 years to take into account changes in resource conditions, user demands, and new technologies. Unlike the initial forest planning effort conducted over 14 years ago, the revision did not start from scratch. The purpose of the revision is to determine any "need to change" and then to incorporate these changes into the management direction of the existing plan. While some of the "need to change" items will address existing management direction, other changes will be based on new or emerging concerns.

The Chugach National Forest Land and Resource Management Plan (Forest Plan) was approved on July 27, 1984. It was developed to meet requirements of the Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA), as amended by the National Forest Management Act of 1976 (NFMA). This Plan was the sixth Forest Plan approved under the National Forest Management Act. Current NFMA regulations (36 CFR 219.10[g]) require that ordinarily a forest plan be revised on a 10-year cycle or at least every 15 years, or whenever the Regional Forester determines that conditions or demands have changed. This is the fifteenth year of the Plan, and the Regional Forester has determined the Forest Plan needs to be revised.

Revision Goals and Objectives

1. Tailor the revision to address the public interests and resource conditions that produce conflict situations that demonstrate a "need for change" to existing management direction.

2. Customize the analysis methods to be used in the revision process to be consistent with the resource values at stake and to be responsive to the public interests and associated conflict situations. Review of Public Interests identified through scoping indicate that recreation, tourism, and habitat for fish and wildlife are especially important values.

3. Emphasize integrated natural resource management techniques. The interdisciplinary team should seek to integrate consideration of multiple-use resources and environmental and amenity values.

4. Emphasize public participation and governmental coordination through the use of "collaborative learning" techniques. The interdisciplinary team should strive for conflict resolution and consensus building where possible.

5. Development of the revised Forest Plan is a complex process. The revision interdisciplinary team should strive to achieve a balance between analysis methods which are grounded in science and the public's desire for simplicity and comprehensibility of the planning process.

Collaboration

Effective public participation is a creative process - more of an art than a science. It relies on building personal relationships with people who have an interests or concerns about public lands.

Collaborative Learning is a recent innovation in public participation theory that has been applied to various ecosystem level decision making processes. The technique is grounded in the theories of conflict management and systems thinking. Collaborative Learning encourages dialogue between diverse communities: scientific, public, and agency. Collaborative Learning promotes the integration of scientific and public/local knowledge about problem situations and helps participants understand the situations systematically. Effective Collaborative Learning results in increased rapport, respect, and trust among participants in the process.

Decisions to be Made

Approval of the revised Forest Plan provides direction to assure coordination of multiple-uses and sustained yield of products and services. Approval of the revised Forest Plan will result in:

1. Establishment of multiple-use goals and objectives.
2. Establishment of forest-wide standards and guidelines.
3. Establishment of management areas and management area prescriptions.
4. Designation of suitable timber land and establishment of allowable timber sale quantity.
5. Non-wilderness allocations or wilderness recommendations.
6. Establishment of monitoring and evaluation requirements.

Scope of the Analysis

For such wide-ranging species as brown bear, viability concerns cannot be adequately addressed at the Forest level. In some cases your analysis will need to extend beyond the Forest boundary and may transect several administrative boundaries. Planning at this scale will help to provide consistent policy and management direction to deal with brown bear viability concerns and the effects of the spruce bark beetle. It will require multi-agency/landowner coordination.

Ecosystem Assessments

Ecosystem Assessments describe where we have been and future trends. They will provide consistent information across agency, political, and administrative boundaries to help make decisions at various planning levels. Assessments define the capabilities of the land and provide information at scales larger and smaller than the Chugach National Forest in order to understand ecological relationships.

A collection of social, economic, physical and biological assessments have been identified as necessary to appraise the state of important resources on the Chugach National Forest. They will address past and present and potential conditions, as well as trends needed to establish a range of alternative possibilities.

Two resource assessments, the Dusky Canada Goose Assessment and the Kenai Brown Bear Assessment are ongoing and are independent of the Forest Plan revision process. In addition, four resource assessments have been initiated to address the entire scope of resource information needs associated with the revised Forest Plan. They are: a Kenai Forest Condition Assessment, a Wildlife Conservation Assessment, a Recreation and Tourism Use Assessment, and a Social and Economic Assessment.

Costs

Based upon the actual expenses of fiscal year 1998 and additional tasks to be funded above the FY 98 level, the projected cost (fiscal year 1999) to meet the revision time-table and produce the associated deliverables is $1,339,542. This does not include the cost of a science advisor which is estimated to cost an additional $136,650 for T.O.S. and salary. Also not included is the estimated cost of the Recreation and Tourism Use Assessment ($139,000) and ten days of environmental affects analysis work for extended IDT members (Mike Stubbs, Dave Blanchet, Dean Davidson, Carol Huber, Leo Keeler - $12,670) for a total amount above the initial budget projection of $288,320. Thus, the total budget projection for FY 99 is $1,627,770. The estimated funding needs for FY 2000 is 1,300,000.

Revision time-table and list of deliverables

The timeline is based on the current staffing level and an estimate of the work needed to complete all revision tasks considering annual leave to be taken and the seasonal nature of public contacts. Should members of the planning team transfer, go on fire assignments or become ill, the dates in the time-table may need to be renegotiated.

Situation statements (ICO's) defined	May 1998
Prescriptions developed	June 1998
Draft Alternatives to the public	January 1999
Conduct collaborative learning workshops to review draft alternatives	January 1999
Science Assessments completed	March 1999
Effects analysis of alternatives complete	June 1999
Alternatives evaluated and preferred alternative recommended	July 1999
DEIS and Draft Forest Plan Prepared	October 1999
Print DEIS and Draft Forest Plan	December 1999
Public distribution of DEIS and Draft Forest Plan	January 1999
Final EIS and revised Forest Plan	June 2000

Organization and Responsibilities

1. **Line Officers** - Dave Gibbons, Forest Supervisor will have "overall responsibility for the preparation and implementation of the Forest Plan and preparation of the environmental impact statement for the Forest Plan. The Forest Supervisor will recommend a preferred Forest Plan alternative to the Regional Forster.

I would like to be involved at the following checkpoints:

- Determining final Situation Statements
- Review the range of management prescriptions available to build alternatives
- Review the range of alternatives to be considered in the EIS
- Review Decision Criteria that will be used to identify the Forest Service perferred alternative
- Determining the scope of Effects Analysis

While NFMA does not speak directly to the responsibilities of the District Line Officers, each District Ranger will be involved throughout the revision effort as they coordinate District support of the revision interdisciplinary team and collaboration with the public and other agencies. District Rangers will also work directly with the Forest Supervisor and the interdisciplinary team during the development of management prescriptions, standards and guidelines, the formulation of alternatives and other tasks.

The Regional Forester will review and approve each phase of the planning process and prepare the Record of Decision which will accompany the Final Environmental Impact Statement.

2. **Revision Interdisciplinary Team** - The revision interdisciplinary team is responsible for completing the revised Forest Plan and associated Environmental Impact Statement. The revision interdisciplinary team will be composed of several individuals representing a wide range of expertise. The Core interdisciplinary team is a subset of the revision interdisciplinary team that is assigned to the revision effort on a full time basis. Some of the interdisciplinary team members (Expanded interdisciplinary team) will not be involved in the effort on a full time basis. Rather, they will be brought

into the process as needed. The Core interdisciplinary team and the involvement of expanded interdisciplinary team members in tasks exceeding 10 consecutive days will be funded by NFPR funds. Employee review of draft products and attendance at "status update meetings" will be funded by their respective staff units.

Revision Interdisciplinary Team

Core interdisciplinary team

Interdisciplinary Team Leader	Gary Lehnhausen
NEPA/NFMA Process manager	Alan VanDiver
Fish Biologist	Steve Zemke
Wildlife Biologist	Ted Schenick
Sociologist	Pat Reed
Recreation/Tourism/Visual Resources	Steve Hennig
Ecologist	Rob DeVelice & John DeLapp
Forester	Warren Oja
Economist	Julie Schafers
GIS Coordination	Karin Preston
Science Advisor	**Vacant**
Computer Assistance/Information manager/Team Support	Yvette Frazier

Extended Interdisciplinary Team

Fire and fuels management	Mike Stubbs
Minerals Specialist	Carol Huber
Transportation Planner	Sam Grimes
Lands Specialist	Leo Keeler
Hydrologist	Dave Blanchet
Soils Specialist	Dean Davidson
Heritage	Dave Hackett
GIS Support	Paula Smith
	Linda Kelly
Public Affairs Specialist	Doug Stackdale
Writer/Editor/Planning record maintenance	Sharon Randall

Responsibilities - While much of the expertise required to address the various Public Interests and associated conflict situations is available on the revision interdisciplinary team (IDT), resource specialists should keep Regional Office specialists and Forest Service Research personnel informed and involved as appropriate. Revision IDT members should also facilitate coordination with industry contacts and specialists from other agencies.

It is essential to involve other governmental entities (local, State of Alaska, and federal) during the revision of the Forest Plan. This involvement will be both formal and informal. The latter may include informal task groups and assessment teams. There will also be a need to coordinate with the Alaska Department of Fish and Game (Division of Subsistence) to determine current and future subsistence uses and to estimate the effects of implementing Forest Plan alternatives.

The Science Advisor will be responsible to coordinate the efforts of the resource assessment studies that are underway with the revision time-table, information needs and funds available.

Dave Gibbons
Forest Supervisor

2000 EXXON VALDEZ TRU! COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$11.6
Travel		$0.0
Contractual		$0.0
Commodities		$2.0
Equipment		$0.5
Subtotal	$0.0	$14.1
General Administration		$1.7
Project Total	$0.0	$15.8
Full-time Equivalents (FTE)		0.4
Other Resources		$17.1

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		

Dollar amounts are shown in thousands of dollars.

Comments: New project proposal

FY00

Project Number: ~~00sss~~ 00458
Project Title: Comparison of Three Techniques for Estimating Fish Population Diversity, Abundance, and Size Structure.
Agency: U. S. Forest Service

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:4/14/99, KEH

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
R. Spangler	Fish Biologist	GS-9		4.5		0.0
E. Kitto	Fish tech	GS-7	2.5	2.8		7.0
Vacant	Bio tech	GS-5	2.0	2.3		4.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		4.5	9.6	0.0	
					Personnel Total	$11.6

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: 00sss
Project Title: Comparison of Three Techniques for Estimating Fish Population Diversity, Abundance, and Size Structure.
Agency: U. S. Forest Service

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRU! COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

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

Commodities Costs:	Proposed
Description	FY 2000
train tickets (personal)	0.2
train tickets (truck)	0.3
camp food ($18.00/ day for 80 days)	1.5
Commodities Total	$2.0

FY00

Prepared:

Project Number: 00sss
Project Title: Comparison of Three Techniques for Estimating Fish Population Diversity, Abundance, and Size Structure.
Agency: U. S. Forest Service

FORM 3B
Contractual & Commodities
DETAIL

2000 EXXON VALDEZ TRU! COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
sampling materials	1	0.5	0.5
			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**	$0.5

Existing Equipment Usage: Description	Number of Units	Inventory Agency
two canoes and gear		1.7
sampling gear		3.3
camp equipment		4.1
salary for R. Spangler		0.8
boat usage (24 days @ 300/ day)		7.2
		17.1

FY00

Project Number: 00sss
Project Title: Comparison of Three Techniques for Estimating Fish Population Diversity, Abundance, and Size Structure.
Agency: U. S. Forest Service

FORM 3B
Equipment
DETAIL

Prepared:

Residual Oiling of Armored Beaches and Mussel Beds in the Gulf of Alaska

Project Number:	00459
Restoration Category:	Research/Monitoring
Proposer:	Dr. Gail V. Irvine DOI-BRD, Alaska Biolgical Science Center
Lead Trustee Agency:	DOI
Cooperating Agencies:	NOAA
Alaska Sea Life Center:	No
Duration:	2nd year, 3-year project (originally proposed 2)
Cost FY 99:	$124.9
Cost FY 00:	$40.8
Cost FY 01:	$20
Cost FY 02:	0
Geographic Area:	Alaska Peninsula, Kenai Peninsula
Injured Resource/Service:	Designated wilderness areas, mussels, intertidal communities

ABSTRACT

During FY2000, efforts will be focused on data and hydrocarbon analyses, preparation of the Final Report, and preparation and submittal of two manuscripts. Funding is requested for presentation of study results at a professional meeting.

For at least 5 years after the *Exxon Valdez* spill, oil mousse persisted on the exposed rocky shores of the Alaska and Kenai Peninsulas in a remarkably unweathered state. We will resample these boulder-armored beach sites in 1999. In addition we will resample several oiled mussel beds in the Gulf of Alaska that had relatively high levels of oiling in 1993, to compare residual oiling of these with oiled mussel beds in Prince William Sound.

INTRODUCTION

This proposal is focused on shoreline oiling in the Gulf of Alaska, the continued presence of subsurface oiling, and the situations that promote oil persistence and retard weathering of stranded oil. The continued contamination of shorelines and biotic communities by residual *Exxon Valdez* oil, especially slowly weathering oil, is a concern of direct relevance to the recovery status of injured resources and services. The *Exxon Valdez* oil spill directly affected the scientific and recreational values including wilderness characteristics of shorelines in Kenai Fjords National Park and Katmai National Park and Preserve. The injury to these values and characteristics is continued by the persistence of oil that degrades the "naturalness" of the coasts. These values and characteristics are clearly stated in both ANILCA (1980) and the Wilderness Act (1964). Additionally, the retention of oil by mussel beds in the Gulf of Alaska and its retarded weathering is of some concern, as the mussel beds are reservoirs of oil that could be released into the environment or contaminate foragers of the mussels.

The exposed Gulf of Alaska habitats where oil has persisted and mussel beds share some common features. They have complicated three-dimensional spatial structures, which allow stranding oil to penetrate into more protected sediments beneath an "armor" of boulders or mussels. Oil thus sequestered is slower to weather (Babcock et al. 1994, 1996, 1998; Irvine and Cusick 1995; Irvine et al. 1997, 1999; Short and Heinz 1997). In fact, oil sampled five years post-spill at sites along national park coasts distant from the spill point was negligibly different from 11-day old *Exxon Valdez* oil (Irvine et al. 1997, 1999). The oil contaminating these coasts was mousse, a water-in-oil emulsion that weathers more slowly internally (Payne and Phillips 1985) and can serve to transport less weathered oil over long distances (Irvine et al. 1997, 1999).

In general, the shorelines impacted by *Exxon Valdez* oil in the Gulf of Alaska region experience higher wave energy than those inside Prince William Sound (Hayes et al. 1977; Hayes and Ruby, 1979; Domeracki et al. 1981; Hayes 1986). Gravel beaches, those composed of mixtures of sand, pebbles, cobbles and boulders, are the most common type of non-bedrock shorelines in the Gulf of Alaska region (Hayes et al. 1976). Gravel beaches exposed to moderate and high wave energies characteristically develop a lag of boulders (stones > 25 cm in diameter) after smaller stones are winnowed away by waves. This boulder lag forms an "armor" that shields the gravel substrate from wave disturbance. Unaffected by all but the largest storm waves, the gravel substrate under a boulder armor can remain undisturbed for years. Observations in the study plots we have established to monitor the persistence of surface oil in Kenai Fjords and Katmai National Parks suggest that on 5 of 6 boulder-armored beaches, no shifting of the boulder armor occurred for 6 years post-spill (Mann et al. 1995).

The length of time that spilled oil remains on a shoreline is thought to depend on the vigor of wave action (Vandermuelen 1977; Gundlach 1983). Frequent large waves breaking on a beach cause vigorous natural cleaning and consequently a short residence time for stranded oil. However, the *Exxon Valdez* spill affected numerous gravel beaches, many possessing the boulder armoring just described. While high wave energy does seem to limit the persistence of surficial

oil on gravel beaches, it may have little effect on the persistence of subsurface oil. Subsurface oil can persist even within high wave-energy gravel beaches because the boulder armor prevents waves from stirring the beach substrate.

Results of our several-year study of oil fate and persistence on beaches in Kenai Fjords and Katmai National Parks indicate sizable reductions in the amount of surficial oiling there. However, observations made in 1994 indicate that significant amounts of subsurface oil remain within gravel beaches along the Katmai coast of Shelikof Strait, even after these beaches were cleaned at the surface. Similar inferences emerge from the studies of Michel and Hayes (1993a, 1993b, 1994, 1996) and Neff et al. (1995) on the fate of shore-stranded oil on Prince William Sound shorelines. This study is a continuation of our monitoring of persistent oil in the Gulf of Alaska region on previously established sites along national park coastlines. Additionally, we will be resampling oiled mussel beds along the Kenai Peninsula.

Study History:
Both the stranded oil persistence study and the oiled mussel bed study were previously funded by the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC). The oil persistence study (R103B, 93090, 94266) was funded for field work in 1992, 1994, and 1999. Six moderately to heavily oiled sites along the Gulf of Alaska coasts of Kenai Fjords National Park and Katmai National Park and Preserve will have been studied for both surficial and subsurface oiling changes, and oil samples analyzed to examine the degree of weathering of the oil. Although five of these sites are very high energy beaches, sampling in 1992 and 1994 indicated that oil mousse persisted in a remarkably unweathered state on these boulder-armored beaches. Mousse sampled in 1989, 1992, and 1994 showed negligible changes in polynuclear aromatic hydrocarbons compared to 11-day old *Exxon Valdez* crude (Irvine et al. 1997, 1999). Our earlier findings also suggest that the low ecological sensitivity ratings previously applied to exposed, rocky shorelines need to be modified when boulder-armored beaches are present.

The study of oiled mussel beds in the Gulf of Alaska (R103B, 93090, 95090), was a companion to studies of oiled mussel beds in Prince William Sound being spearheaded by NOAA. The objectives of the previous study were to establish the geographical extent and intensity of the oiling of mussel beds, and to determine the rate of recovery of those beds that were oiled. In 1999 we will be resampling the 3 sites sampled in 1995 that had the highest levels of oiling.

NEED FOR THE PROJECT

A. Statement of Problem

Oil from the wrecked T/V*Exxon Valdez* spread from Prince William Sound out into the Gulf of Alaska, stranding on coastlines of the Kenai and Alaska Peninsulas and the Kodiak Archipelago. As recently as 1993 and 1994, oil remained in particular types of locations in the Gulf of Alaska. These included boulder-armored intertidal beaches and mussel beds. As stated on page 19 of the

Invitation to Submit Restoration Proposals, "The oil that remains in the environment and the extent and significance of any biological exposure to that oil continues to be an important concern of direct relevance to the recovery status of injured resources and services."

The persistence of oil on national park coastlines (sites are located on Kenai Fjords and Katmai National Parks) constitutes injury to the scientific, recreational, and wilderness values of the parks. While we assess the significance of the oiling, we will also be assessing the recovery of oiled sediments through natural processes of physical and chemical weathering of the oil.

The three-dimensional topography of mussel beds creates a situation similar to that of boulder-armored beaches, where oil has penetrated finer sediments beneath the mussels but is protected to some extent from disturbance and weathering processes. The same questions regarding the retention and weathering can be asked for mussel beds as for the boulder-armored beaches. Additionally, since predators feed on the mussels, there is the potential for exposure of the predators to hydrocarbons. In the Nearshore Vertebrate Predator project in PWS, invertebrate-feeding predators (sea otters and Barrow's goldeneye ducks) have shown elevated levels of biomarkers that may indicate increased exposure of the animals to hydrocarbons, though the linkages to sources and the significance of the results are not known. Results from various projects presented at the recent 10th year anniversary Restoration Conference reinforce this view, and elevate the concerns regarding residual oiling as a source of continuing contamination.

B. Rationale/Link to Restoration

This project has a very basic link to oil spill effects: we are studying the persistence and degradation of stranded oil. The project is primarily a monitoring project. The monitoring elements are straightforward reassessments of the persistence and degradation of oil on boulder-armored beach sites and in oiled mussel beds. In 1999, we will be monitoring surface-oil weathering at six sites already established in the Gulf of Alaska, as well as subsurface oiling. Both physical and chemical weathering of the oil will be assessed. Also in 1999, we'll be resampling oiled mussel beds at three locations using previously established techniques to determine the chemical weathering of hydrocarbons in both mussel tissue and sediments underlying the mussels. The results obtained will help describe the progress of recovery of oiled sediments and biota. Results will guide decisions about whether future restoration efforts are desirable and how they might be implemented.

Our results will also help predict the effects of future oil spills in this region and guide future oil-spill response efforts. In particular, our results suggest that a revision to the Ecological Sensitivity Indices (ESI's) for boulder-armored exposed rocky shores may be necessary, and that instead of being rapidly cleansed by wave action, these sites are locations where oil may persist for decades with minimal weathering. This revision could lead to changes in response and cleanup strategies for these habitats.

C. Location

Sites that are being resampled are located in the Gulf of Alaska along Kenai Fjords and Katmai National Park coasts, and the outer Kenai Peninsula.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

At present, there are no communities in the vicinity of the study areas. We will be happy to present information to the nearest local communities and/or prepare lay abstracts of our work.

PROJECT DESIGN

A. Objectives

1999:

1. Monitor (a) surface and (b) subsurface oil at 6 previously established sites along the Gulf of Alaska coast. Determine the physical extent and chemical weathering of the oil.

2. Monitor recovery of a select subset (3) of previously sampled Gulf of Alaska oiled mussel beds.

2000:

3. Preparation of Final Report and submission of two manuscripts to peer-reviewed journals.

4. Presentation at a professional conference.

B. Methods

Sampling methods at the boulder-armored beaches will include: relocation and resampling of permanently marked quadrats, gas chromatography/mass spectroscopy (GC/MS) analysis of oiled sediment samples from each site, and analysis of sub-surface oiling by sampling "dip stones". At the oiled mussel sites, 3 pooled samples each of mussels and sediments will be taken relative to a transect laid along the zone of heaviest oiling of the mussel bed.

The following section details the hypotheses and methods associated with each of the Objectives listed above.

1. a. *Monitor surface oil at 6 previously established sites.*
Continued monitoring of the fate of stranded surface oil on Gulf of Alaska shorelines indicates gradual disappearance of this oil. We hypothesize that surficial oil will have disappeared entirely by 1999 (5 years since the last sampling and 10 years post-spill).

Methods established in 1994 will be used to reassess the surficial oiling at the 6 sites previously established along the coasts of Kenai Fjords and Katmai National Parks. Oil

percent cover will be estimated visually in the field within 10-25 quadrats per site previously set up and marked by rock bolts. Independent estimates by observers will be compared and estimates modified until all observers agree on oil coverage within 5% (Dethier et al. 1993).

1. b. *Monitor subsurface oil at the 6 previously established Gulf of Alaska sites.*
We hypothesize that oil trapped in the subsurface of boulder-armored gravel beaches will remain there for lengthy intervals and will weather slowly since it is shielded from both physical abrasion and evaporation. We will monitor the persistence and chemical weathering of the buried oil by systematically examining "dip stones" within the oiled area and by analyzing 2 samples of oiled sediments taken at each site via GC/MS. Both of these methods were used in 1994. The extent of subsurface oiling will be assessed via dip stones, which are elongate rocks protruding out of the surface but extending down into the subsurface oil layer. The ideal dip stone extends vertically below the lowest subsurface oil, illustrating the maximum depth of oiling at that spot. GC/MS analyses of oil samples will provide an indication of oil weathering in addition to identifying the oil as *Exxon Valdez* oil. The Auke Bay Laboratory has offered to conduct, gratis, GC/MS analyses of 6 oil samples from these sites. We will analyze an additional 6 samples in order to replicate our previous sampling effort.

2. *Monitor recovery of 3 Gulf of Alaska mussel beds previously sampled in 1993.*
Previous sampling of oiled mussel beds along the Gulf of Alaska coast suggested that levels of hydrocarbons in mussels and in the sediments underlying the mussels were declining (Irvine and Cusick 1995; Babcock et al. 1996, 1998). However, several mussel beds sampled in 1995 had levels of hydrocarbons above baseline levels (50 μg/g total petroleum hydrocarbons [TPH] wet weight in sediments and 0.09 μg/g total polynuclear aromatic hydrocarbons [TPAH] dry weight in mussels). These baseline levels are determined from the minimum detection limits of the analytical instruments and historical data from unoiled sites in Prince William Sound. We will examine three beds on the outer Kenai Peninsula (Tonsina Bay, Port Dick and Morning Cove) in order to assess the recovery of these assemblages. We predict that levels should have declined further, perhaps to background levels. We will use the same methods as in previous years, and will take 3 pooled samples each of mussels and underlying sediments. Samples will be analyzed by GC/MS at the Auke Bay Fisheries Laboratory. NOAA will be resampling beds in PWS, and combination of PWS and GOA sampling should provide a broad picture of the recovery status of these oiled beds.

Statistical Analyses

Shoreline Oil Persistence and Weathering:
Surficial Oil: Surface oiling is reassessed in marked quadrats by estimates of oil percent cover. Percent cover data for individual quadrats will be compared through time (1994 and 1999 data) via pair-wise tests. As for all tests discussed, the data will be tested for normality and the

appropriate parametric or non-parametric test chosen. The power to detect change is usually increased when fixed quadrats are used as a sampling method, although the resulting inference is limited to changes within that particular quadrat. Since we have only one year of data, we cannot project the anticipated variability within quadrats over time.

Subsurface Oiling: Subsurface oiling will be assessed through sampling of dip stones at each site. Means and ranges of the depth of oiling for each site will be compared through time.

Oil Weathering: The presence and relative abundance of polynuclear aromatic hydrocarbons (PAH) within samples will be compared, and a weathering index based on a first-order kinetic loss rate model of Short and Heinz (1997) will be used to compare the degree of weathering of different samples at the same and different sites.

Oiled Mussels:
The parameters described above to be used in comparing the oiled sediment samples (relative abundances of PAHs and an EVO weathering index) will be used to compare the oil in samples of mussel tissue and underlying sediment. The change in the percent phenanthrenes of samples in samples analyzed by GC/MS will also be compared (Babcock et al. in prep). Additionally, uv-fluorescence (Krahn et al. 1991) will be used initially to analyze sediments associated with the mussel beds. Data from individual sites will be compared through time using paired tests. The data from these outer Kenai Peninsula sites will also be compared to data from PWS. Power analyses from another mussel hydrocarbon monitoring study (Kinnetics 1993) suggests that triplicate sampling such as we propose could have the statistical power of 80% to detect a change or difference of 60% (alpha = 0.05) at two sites or two sampling times at the same station.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

NOAA is a cooperating agency, as one of our Principal Investigators, Dr. Jeff Short, is allied with the NOAA's Auke Bay Fisheries Laboratory. We also expect to cooperate with the NOAA's Principal Investigators on the PWS Oiled Mussel project, although we are submitting separate proposals.

SCHEDULE

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

January 15:	Complete data analysis and hydrocarbon analyses from 1999 field season
January 18-28:	Attend Annual Restoration Workshop
April 15:	Submit Draft Final Report (FY99 findings)
September 30:	Submit manuscripts to peer-reviewed journals

B. Project Milestones and Endpoints

Objective 1: *Monitor surface and subsurface oil at 6 previously established sites along the Gulf of Alaska coast. Determine the physical extent and chemical weathering of the oil.*
Field monitoring should be completed during summer 1999. Analysis of data will occur in the fall, and results of the hydrocarbon analyses are expected in Jan. 2000.

Objective 2: *Monitor recovery of 3 Gulf of Alaska mussel beds previously sampled in 1993.*
The mussel beds will be sampled during the summer of 1999. Results of the hydrocarbon analyses are expected in Jan. 2000.

Objective 3: *Preparation of Final Report and submission of two manuscripts to peer-reviewed journals.*
As stated in greater detail above, the field work for the project is expected to be completed in FY99, with data analysis the following fall, hydrocarbon analyses in the fall and winter, and a draft final report submitted in April 2000. We expect to submit two manuscripts in FY 2000 (one in conjunction with NOAA's oiled mussel project).

Objective 4: *Presentation to a professional conference.*
We plan to present the findings of our research at a professional conference in FY2000.

C. Completion Date

We initially planned on completing all aspects of this project by the end of FY 2000, however, we now anticipate preparation and submittal of an additional manuscript and a presentation at a conference in FY 2001.

PUBLICATIONS AND REPORTS

We have a paper covering our previous geomorphology-oiling results in press at Marine Pollution Bulletin, and another manuscript on spill-wide recovery of oiled mussels (lead by NOAA), due to be submitted shortly. In FY 2000, we plan to submit another paper encompassing our 1999 results on oil persistence and degradation at high-energy armored beaches. We want to examine the results before before deciding which journal to submit to. We will participate in preparation of an additional oiled mussel manuscript that looks at the spill-wide recovery of oiled mussel beds. In FY 2001, we plan to prepare an additional manuscript on oiled mussels ("Spatial variability in oiling within mussel beds distant from the Exxon Valdez spill origin"). This work will also be presented at a scientific meeting.

We will prepare a Draft Final Report by April 15, 2000 and Final Report in FY 2000.

PROFESSIONAL CONFERENCES

Results from this project will be presented at a conference in FY2000, with another presentation planned for FY2001.

NORMAL AGENCY MANAGEMENT

This project is not at all part of any normal agency management. It is being proposed solely because the *Exxon Valdez* oil spill occurred and contaminated coastlines and biota.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project is built on the framework of two previously funded EVOSTC projects that the Prinicpal Investigators have been involved with. One of our PI's is with NOAA's Auke Bay Laboratory, and we expect to coordinate data analysis and results from the oiled mussel samples with the NOAA PI's examining oiled mussels in Prince William Sound.

PRINCIPAL INVESTIGATORS

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PRINCIPAL INVESTIGATORS

Gail V. Irvine

Education: B.A., 1969, University of California, Santa Barbara (Zoology)
M.S., 1973, University of Washington, Seattle (Zoology)
Ph.D., 1983, University of California, Santa Barbara (Aquatic and Population Biology)

Relevant Experience:

1984-1990: Marine Biologist with the Minerals Management Service. Analyzed effects of potential oil spills in Alaskan marine waters. Technical advisor for post-spill studies conducted by the Smithsonian Institution (with Minerals Management Service funding) in Panama, following the Galeta oil spill. (I had previously done research on coral reefs in Panama, including the Galeta reef).

1990- 1994: Coastal Resources Specialist with the National Park Service, Anchorage, Alaska. Coordinated and conducted coastal projects along marine coastlines of Alaskan national parks, including Kenai Fjords, Katmai and Lake Clark National Parks. Involved in emergency response to potential oil spill in Glacier Bay National Park.

1992-1995: Principal Investigator on Oiled Mussel Project, Gulf of Alaska.

1992-1995: Project Manager, then a Principal Investigator on the study, "Fate and Persistence of Stranded Oil on National Park Coastlines".

1994- present: Research Ecologist with the National Biological Survey, then the U.S. Geological Survey, Biological Resources Division.

1995- present: Opportunistic cooperator with Principal Investigators of the Nearshore Vertebrate Predator Project. Studying recruitment dynamics of invertebrate species.

1995- present: Principal Investigator on a project to: "Develop coastal monitoring protocols and process-based studies to address landscape-scale variation in coastal communities of Glacier Bay National Park and Preserve, Katmai National Park and Preserve, and Wrangell-St. Elias National Park and Preserve."

Project Responsibilities: Project coordination, study design, field work, mussel sampling, data analysis, preparation of proposal, report and manuscripts.

Dan H. Mann

Education: B.A., 1976, University of Washington (Anthropology)
M.S., 1978, University of Washington (Entomology, ecology)
Ph.D., 1983, University of Washington (Quaternary geology, paleoecology)

Relevant Experience:

1983-1985: Postdoctoral Research Associate, University of Washington, studying coastal geomorphology and arctic soil genesis in Svalbard, arctic Norway.

1989-1991: Coastal geological consultant with Woodward-Clyde and Exxon Corporation. Worked as a coastal geomorphologist after the *Exxon Valdez* oil spill in Prince William Sound. Led teams assessing oil pollution and biological hazards on shorelines and prescribing cleanup methods. Developed methods for monitoring the fate of stranded oil on high wave-energy coasts. Advised Exxon managers on cleanup methods and priorities.

1992: Visiting professor, Alaska Quaternary Center, University of Alaska, Fairbanks.

1993-1995: Principal Investigator on *Exxon Valdez* Trustee project: "Fate and Persistence of Stranded Oil on National Park Coastlines".

1993-present: Research Associate, Institute of Arctic Biology, University of Alaska, Fairbanks. Conducting a major study on "Coastal geomorphology and archaeology in the Gulf of Alaska", with Dr. Aron Crowell of the Smithsonian Institution. Study is concentrated on marine coastlines of national parks ringing the Gulf of Alaska. Involved in other studies of Quaternary geology and paleoecology, including coastal processes.

Project Responsibilities: Geomorphology, study design, field work, data analysis, report and manuscript contributions.

Jeffrey W. Short

Education: B.S., 1972, University of California, Riverside (Biochemistry and Philosophy)
M.S., 1982, University of California, Santa Cruz (Physical Chemistry)

Relevant Experience:

1989- present: Established and managed the hydrocarbon analysis facility at ABL to analyze hydrocarbon samples generated by the *Exxon Valdez* NRDA effort (about 20%) of these samples were analyzed at ABL).

1989-1992: Principal Investigator, *Exxon Valdez* project Air/Water #3: Determination of petroleum hydrocarbons in seawater by direct chemical analysis and through the use of caged mussels deployed along the path of the oil spill.

1991-1996: Principal Investigator, *Exxon Valdez* project Subtidal #8: Development of computer-

based methods for global examination of sediment and mussel hydrocarbon data produced for the *Exxon Valdez* NRDA effort for systematic bias, and for identification of probable sources of hydrocarbons. In addition, this project produced both hard-copy and computer display maps of all the sediment and mussel hydrocarbon data.

1994-1995: Initiated data analysis and pilot projects that established the role of pristane in Prince William Sound.

1996-1997: Principal Investigator, projects 96195 and 97195.

Project Responsibilities: Hydrocarbon analyses and interpretation, report and manuscript contributions.

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2000 EXXON VALDEZ TRU! COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	FY 1999	FY 2000	ADEC	ADF&G	ADNR	USFS	DOI	NOAA
							$35.4	$5.4
Personnel	$0.0	$19.5						
Travel	$0.0	$2.2						
Contractual	$0.0	$15.0						
Commodities	$0.0	$0.1						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$36.8			Estimated FY 2001	Estimated FY 2002		
General Administration	$0.0	$4.0						
Project Total	$0.0	$40.8			$20.0	$0.0		
Full-time Equivalents (FTE)	0.0	0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0			$0.0	$0.0		

Comments:

Cooperative Agreement with University of Alaska, Fairbanks. Indirect Costs 15%, USGS-UAF agreement

Manuscript preparation: Total of 1.5 mo of personnel time (Irvine-0.75 mo; Mann- 0.5 mo; Short-0.25 mo)

Additional year of funding needs projected (FY 2001): Funding is being requested to prepare an additional manuscript, cover page charges, and travel to a conference.

FY00

Prepared: 4/99

Project Number: 00459
Project Title: Residual Oiling of Armored Beaches and Mussel Beds in the Gulf of Alaska
Lead Agency: DOI-BRD

FORM 2A
MULTI-TRUSTEE
AGENCY SUMMARY

	Authorized	Proposed

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	FY 1999	FY 2000
Personnel		$14.8
Travel		$2.2
Contractual		$15.0
Commodities		$0.1
Equipment		$0.0
Subtotal	$0.0	$32.1
General Administration		$3.3
Project Total	$0.0	$35.4
Full-time Equivalents (FTE)		0.2
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

		Estimated FY 2001	Estimated FY 2002		
		$20.0			

Dollar amounts are shown in thousands of dollars.

Comments:

FY00

Prepared: 4/99

Project Number: 00459
Project Title: Residual Oiling of Armored Beaches and Mussel Beds in the Gulf of Alaska
Agency: DOI-BRD

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FY 2000
Name	Position Description					

Dr. Gail Irvine	Marine Ecologist	GS-12	2.0	7.4		14.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.0	7.4	0.0	
					Personnel Total	$14.8

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
Anchorage-Salt Lake City	1.0	1	6	0.2	2.2
(Present findings at Ecological Society of America Mtgs)					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.2

FY00

Prepared:

Project Number: 00459
Project Title: Residual Oiling of Armored Beaches and Mussel Beds in the Gulf of Alaska
Agency: DOI-BRD

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FY 2000
Cooperative Agreement with University of Alaska	13.7

Final report production	0.8
Registration for scientific meetings	0.3
Duplication	0.2
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$15.0

Commodities Costs:	Proposed
Description	FY 2000
Film	0.1
Commodities Total	$0.1

FY00

Prepared:

Project Number: 00459
Project Title: Residual Oiling of Armored Beaches and Mussel Beds in the Gulf of Alaska
Agency: DOI-BRD

FORM 3B
Contractual & Commodities DETAIL

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
			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

FY00

Project Number: 00459
Project Title: Residual Oiling of Armored Beaches and Mussel Beds in the Gulf of Alaska
Agency: DOI-BRD

FORM 3B
Equipment
DETAIL

Prepared:

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$4.7
Travel		$0.0

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$4.7			Estimated FY 2001	Estimated FY 2002		
General Administration		$0.7						
Project Total	$0.0	$5.4						
Full-time Equivalents (FTE)		0.0						
			Dollar amounts are shown in thousands of dollars.					
Other Resources								

Comments:

FY00

Prepared:

Project Number: 00459
Project Title: Residual Oiling of Armored Beaches and Mussel Beds in the Gulf of Alaska
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
Dr. Jeff Short	Hydrocarbon Chemist	GS-13	0.5	9.3		4.7
						0.0
						0.0
						0.0

						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.5	9.3	0.0	
					Personnel Total	$4.7

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

FY00

Prepared:

Project Number: 00459
Project Title: Residual Oiling of Armored Beaches and Mussel Beds in the Gulf of Alaska
Agency: NOAA

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	
Description	Proposed FY 2000

When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed FY 2000
Description	
Commodities Total	$0.0

FY00

Prepared:

Project Number: 00459
Project Title: Residual Oiling of Armored Beaches and Mussel Beds in the Gulf of Alaska
Agency: NOAA

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
			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

FY00

Project Number: 00459
Project Title: Residual Oiling of Armored Beaches and Mussel Beds in the Gulf of Alaska
Agency: NOAA

FORM 3B
Equipment
DETAIL

Prepared:

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$9.0
Travel		$1.6
Contractual		$1.2
Commodities		$0.1
Equipment		$0.0
Subtotal	$0.0	$11.9

LONG RANGE FUNDING REQUIREMENTS

		Estimated	Estimated		

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

Indirect					FY 2001	FY 2002		
Project Total	$0.0	$11.9						-
Full-time Equivalents (FTE)		0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

See attached form 4B's for detail
UAF: University of Alaska, Fairbanks, Cooperative Agreement ; 15% indirect costs (UAF-USGS rate)

FY00

Prepared:

Project Number: 00459
Project Title: Residual Oiling of Armored Beaches and Mussel Beds in the Gulf of Alaska
Agency: University of Alaska, Fairbanks (UAF)/ Agency:DOI-BRD

FORM 4A
Non-Trustee
SUMMARY

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2000
	Dr. Dan Mann	Geomorphologist	1.5	6.0		9.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0

						0.0
						0.0
						0.0
						0.0
	Subtotal		1.5	6.0	0.0	
					Personnel Total	$9.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2000
	Fairbanks-Anchorage, RT	0.3	2	5	0.2	1.6
	(includes travel to EVOS Annual Restoration Workshop)					0.0
						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: 00459
Project Title: Residual Oiling of Armored Beaches and Mussel Beds in the Gulf of Alaska
Agency: DOI-BRD

FORM 4B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FY 2000
Page charges	1.0
Duplication	0.2

Contractual Total	$1.2

Commodities Costs:	Proposed
Description	FY 2000
Film	0.1
Commodities Total	$0.1

FY00

Prepared:

Project Number: 00459
Project Title: Residual Oiling of Armored Beaches and Mussel Beds in the Gulf of Alaska
Agency: University of Alaska, Fairbanks (UAF)/ Agency: DOI-BRD

FORM 4B
Contractual & Commodities DETAIL

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
				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: 00459
Project Title: Residual Oiling of Armored Beaches and Mussel Beds in the Gulf of Alaska
Agency: University of Alaska, Fairbanks (UAF)/ Agency: DOI-BRD

FORM 4B
Equipment
DETAIL

Prepared: