19.09.02 (3 & 12)

Sea Otter Monitoring

Project Number:	01333
Restoration Category:	Enhance/Replace Subsistence Resources
Proposer:	Native Village of Eyak
Lead Trustee Agency:	Native Village of Eyak, a Federally Recognized Tribal Government.
Cooperating Agencies:	DOI, ADFG, NMFS, & CRRC.
Duration:	1st year of a five year project.
Cost FY 01:	$100,000
Cost FY 02:	$100,000
Cost FY 03:	$100,000
Cost FY 04:	$100,000
Cost FY 05:	$100,000

Geographic area: Copper River, Prince William Sound.
Injured Resource/Service Subsistence

Abstract:

The Sea Otters in Orca Inlet have been dying and washing up on the beaches in the past few years. This has happened for the past few years. The problem is getting worse. We know the cause. We need to do some study to find a way to prevent these needles deaths.

NATIVE VILLAGE OF EYAK
P.O. Box 1388, Cordova, Alaska 99574
Tel 907-424-7738 Fax 907-424-7739

April 14, 2000

Molly McCammon
Executive Director
Exxon Valdez Oil Spill Trustees Council
645 G Street, Suite 401
Anchorage, Alaska 99501-3451

Dear Molly

Enclosed is a restoration proposal to monitor the sea otters in and around the Eyak/Cordova area. In the past few years, during the winter months, many of the sea otters have been washing up on the beaches of Orca Inlet. From January,2000 up to date over 100 sea otters have been picked up between Hartney Bay and Nelson Bay. The cause is very clear. The necropsies show the cause of death to be parasites and bone impaction to the stomachs and intestines. These are picked up by the sea otters from feeding at the outfalls from the cannery waste that is pumped into Orca Inlet.

There is a direct tie to the Exxon Valdez Oil Spill. The polleck waste that is the cause of this, comes from a polleck fishery that was started after EVOS funded studies showed there were polleck in harvestable quantities in PWS.

Our Tribe became involved when we were accused of killing sea otters and not picking them up. Now we are being accused of trying to shut down the canneries.

We all need to get to the bottom of this problem.

We are requesting technical assistance from EVOS for this proposal.

Sincerely yours
Bob Henrichs
President
Native Village of Eyak
Traditional Council

Survival of Adult Murres and Kittiwakes in Relation to Forage Fish Abundance

Project Number:	01338
Restoration Category:	Research
Proposed By:	U.S. Geological Survey (PI- John F. Piatt)
Lead Trustee Agency:	DOI-USGS
Cooperating Agencies:	DOI-FWS
Alaska SeaLife Center	no
Duration:	4th year, 4-year project
Cost FY 01:	$47,200
Cost FY 02	$0
Geographic Area:	Cook Inlet, Gulf of Alaska
Injured Resource:	Multiple resources

ABSTRACT

Some seabird populations damaged by the *Exxon Valdez* oil spill continue to decline or are not recovering. In order to understand the ultimate cause of seabird population fluctuations, we must measure productivity, recruitment, and adult survival. Recent APEX studies focused on measuring productivity only. Recruitment measurement demands an unrealistic study duration. We propose to augment current studies in lower Cook Inlet that relate breeding success and foraging effort to fluctuations in forage fish density by using banding and resighting to quantify the survival of adult common murres and black-legged kittiwakes.

INTRODUCTION

Some seabird populations in the Gulf of Alaska have undergone marked fluctuations during the past few decades (Hatch and Piatt 1995; Piatt and Anderson 1996), including periods of decline or non-recovery. Ultimately, the ability of injured or declining seabird populations to recover depends on: 1) breeding success, or productivity; 2) fledgling survival and subsequent recruitment; and 3) overwinter survival of adults (Harris and Wanless 1988). Without concurrent measurement of at least two of these three parameters, it is difficult to determine which factor is most limiting to a population's recovery.

Mechanisms that regulate seabird populations by influencing productivity, recruitment, and adult survival are poorly understood, but food supply is clearly important (Cairns 1992). Studies sponsored by the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) in 1995-99 (APEX, Restoration Project 00163) have shown linkages between food supply and population fluctuations. Exactly which parameters of reproductive strategy are driven by food supply, and so drive population fluctuations, remain unclear. To date, APEX has focused on forage fish availability and its relationship to energy expenditure and productivity.

We are determining the overwinter survival of adult common murres (*Uria aalge*) and black-legged kittiwakes (*Rissa tridactyla*) using established banding and resighting techniques at two of the colonies investigated under APEX. Results of past work show clear differences in prey availability between the two colonies, with forage fish being scarce around Chisik Island and abundant around Gull Island. Both seabird species must work significantly harder at Chisik to provide food to their chicks. This difference appears to be manifested in sharply reduced kittiwake production at Chisik Island. Observing that kittiwake populations have been steadily declining at Chisik while increasing at Gull, one might be tempted to conclude that weak productivity and recruitment are driving the Chisik kittiwake population declines. However, while murres (at least in recent years) have been similarly productive at Chisik and Gull, the Chisik Island murre population has historically declined at an even greater rate than the kittiwake population.

From these data we conclude that the murre population decline at Chisik Island and concurrent increase at Gull Island may be attributable to differences in adult survival rates. Measurement of survival rates, in coordination with APEX's focus on food supply, energy expenditure and colony productivity, should help to more completely resolve the mechanisms underlying seabird population fluctuations, particularly for those species such as murres that are able to buffer against periods of food shortage by increasing foraging effort (Burger and Piatt 1990; Irons 1992).

Our continued research will measure adult survival of both murres and kittiwakes at Chisik and Gull Islands. We will use conventional banding/resighting methods to establish both species' adult survival rates. Working in collaboration with the Cook Inlet Seabird and Forage Fish Studies (CISeaFFS) component of the APEX project, we will compare survival between colonies

in relation to foraging stress, breeding success, and forage fish abundance as determined during APEX surveys in 1995-1999. Foraging stress from breeding effort is probably a major contributor to adult overwinter mortality (Golet et al. 1998). Our work will enhance understanding of the relationships among survival, reproduction; and foraging energy expenditure in kittiwakes and murres in lower Cook Inlet. In a broader context, our research will clarify the mechanisms and limiting parameters underlying natural population declines or the failure of injured populations to recover.

NEED FOR THE PROJECT

A. Statement of the Problem

Research has provided few clear examples of how seabird population biology is affected by changes in prey availability (Hunt et al. 1991). Consequently, it has been difficult to understand the non-recovery of some EVOS-damaged seabird populations because natural changes in forage fish stocks may have also contributed to their decline. The picture is further complicated by our inability to pinpoint which aspect of population biology ultimately drives population fluctuations. To determine the cause of population declines or non-recovery, the population's productivity, recruitment, and adult survival should be measured concurrent with evaluation of available food supply (Cairns 1992).

Recent EVOSTC-funded work (APEX, Restoration Project 00163M) measured productivity and foraging differences of seabirds in response to fluctuating prey availability. Results from research conducted in lower Cook Inlet show a correspondence between kittiwake productivity and forage fish availability to breeders. There is no correspondence, however, in species such as the murre which are able to increase foraging effort in response to decreasing forage fish abundance (Burger and Piatt 1990, Zador and Piatt 1999). Differences in recruitment and/or adult survival are thus implicated as important determinants of population fluctuations. Yet their relative importance has not been established by EVOSTC researchers, despite past work which has shown that variation in either recruitment or adult survival could obscure or even offset population fluctuations apparently driven by productivity differences (Hudson 1985).

Since murres and kittiwakes do not commence breeding until they are several years old (Hudson 1985; Aebischer and Coulson 1990), it is not feasible to measure recruitment in Cook Inlet seabird populations within the time frame required by EVOSTC funding. Measurement of adult overwinter survival has not yet been studied within a complete ecological framework, and has been identified by APEX reviewers as an important topic for expanded research in pursuit of understanding population fluctuations and recovery.

B. Rationale

Population changes are continually being driven by natural ecosystem changes, and are occasionally driven by anthropogenic perturbations such as the *Exxon Valdez* oil spill. In order to separate natural population fluctuations from anthropogenic population changes, we must have a complete understanding not only of the factors which drive population changes (e.g. change in prey availability) but also of the population biology parameter which is most altered by those driving forces. Annual productivity in relation to varying prey availability has been studied, but cannot explain all observed population trends. It is not feasible to measure chick survival and recruitment. Therefore, to assess the potential for recovery of seabirds affected by the spill by pinpointing the cause of population trends, a study of adult survival and its relationship to prey availability is required.

In collaboration with the ecosystem-based study of seabird foraging conditions and breeding biology conducted by APEX in lower Cook Inlet (Restoration Project 00163M), we have a unique opportunity to assess not only the role of adult survival in seabird population fluctuations, but also the suspected linkage between foraging effort during the breeding season and adult overwinter survival. By choosing species with different long-term breeding strategies (kittiwakes maintain investment in reproduction at relatively constant [high] levels despite variation in food supply; murres adjust reproductive effort in relation to prey availability by altering buffer or "loafing" time) we will address questions raised by APEX work that shows linkage between prey availability and population fluctuation in some species (kittiwake) but only implies a linkage in others (murre). Refined understanding of foraging effort in relation to food supply will further our understanding of the costs of breeding in murres and kittiwakes. Stress induced by increased foraging effort in response to poor foraging conditions (Kitaysky et al. 1999a) may explain variation in adult survival.

C. Location

The proposed research will be undertaken in lower Cook Inlet, Alaska. The project's benefits will be realized throughout the EVOS area, in the form of enhanced understanding of seabird population trends and recovery mechanisms. Homer, Alaska is the only community that may be directly affected by the proposed research (as detailed below).

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Gull Island in Kachemak Bay is owned by the Seldovia Native Association (SNA). Limited subsistence use occurs during summer, with occasional egging and harvesting of juvenile birds (Fred Elvsaas, pers. comm.). It is also a major tourist attraction for visitors to Homer. Permission to work on and around the island has been obtained under the provision that annual reports of findings be made available to the SNA. We inform the local tour boat operators about our activities so that our presence at the island can be explained to visiting tourists. Chisik Island

is managed by the Alaska Maritime National Wildlife Refuge, and we will employ charter vessels from Homer to support field work there. Chisik Island supports a small, seasonal fishing community and we will inform the summer residents about the nature and purpose of our activities. Whenever possible, equipment and other resources will be acquired locally.

PROJECT DESIGN

A. Objectives

1. To determine adult common murre and black-legged kittiwake overwinter survival rates, using conventional banding and resighting methods.

2. To relate differences in common murre and black-legged kittiwake overwinter survival to differences in prey availability, foraging effort and physiological stress during the breeding season.

3. To relate differences in common murre and black-legged kittiwake overwinter survival to differences in breeding success.

Background

We will conduct the proposed research at Chisik and Gull Islands, in lower Cook Inlet. Chisik Island has relatively low prey availability within typical murre/kittiwake foraging ranges, while Gull Island has high prey availability. The Chisik Island populations of both murres and kittiwakes have shown steady declines over the past two decades, in contrast to the Gull Island populations which are expanding. Recent APEX work has shown a significant relationship between breeding success and foraging effort for kittiwakes, but not for murres. Both species show increased foraging effort with decreased prey availability, but it appears that murres have a greater range of foraging effort within which they can still successfully produce chicks, as indicated by past studies (Burger and Piatt 1990, Zador and Piatt 1999). This raises the question: Is there a delayed or hidden cost to successful breeders that have had to "work harder" to raise their chicks? One way such a cost may be expressed is in decreased annual adult survival.

Measurement of survival:

Adult overwinter survival in seabirds has typically been measured by intensive banding and resighting programs (Harris and Wanless 1988; Aebischer and Coulson 1990; Hatchwell and Birkhead 1991; Hatch et al. 1993; Sydeman 1993, Erikstad et al. 1995). A suite of potential confounding factors (loss of bands, emigration, intracolony movement, observer failure to see marked birds) complicate survival estimates based on banding and resighting (Harris and Wanless 1988; Hatch et al. 1993). Models have been developed which account for some of these problems (Pollock et al. 1990); overcoming the remaining uncertainties depends directly on the

amount of personnel effort that can be dedicated to banding and resighting work. Intensive effort will be required to resight banded birds, especially during the pre- egg-laying stage. Adult common murres are particularly difficult to resight, due to the murre's compact body posture while at the nest site.

Measurement of foraging effort and physiological stress:

Increased foraging effort may be the most important contributor to reduction in adult seabird survival (Golet et al. 1998), illustrating the trade-off between yearly reproductive output and longevity. In 1997-2000 we are measuring murre and kittiwake foraging effort (in terms of bird-hours spent away from the colony) using a series of 6-8 all-day nest watches spread throughout the incubation and chick-rearing periods. All-day watches give information on nest-site attendance (a measure of 'loafing time'[Zador and Piatt 1999], foraging trip duration, and chick provisioning rate. For example, during four years (1995-1998) of study we have observed that average foraging trips are more than 50% longer at Chisik Island than Gull Island (murres: 190 vs. 122 min; kittiwakes 254 vs. 166 min; respectively).

All of the birds captured for banding are also sampled for levels of corticosteroid stress hormones in the blood. We have already found a strong relationship between stress hormone levels and food (energy) intake (Kitaysky et al. 1999b) in growing chicks, and differences in baseline levels of stress hormones between the 'food-rich' colony at Gull Island and the 'food-poor' colony at Chisik Island (Kitaysky et al. 1999a). We will continue to analyze baseline corticosteroid levels in all birds banded for the survival study, and will eventually be able to relate survival to stress in individual birds, as well as between colonies.

B. Methods

Sample Size and Survival Statistics: Assuming a binomial distribution (sample unit being an individual adult, with survival being a yes or no), a power analysis of sample size in a two by two table predicts that a sample size of 47 marked birds per island would resolve a 6% difference in survival between colonies with acceptable statistical power and confidence (Table 1). To double the resolution (3%) would require a sample size nearly five times greater. However, a sample size of 185 is predicted to resolve a 4% difference with strong power and significance at the 0.05 level. Previous studies have reported murre survival rates ranging from 87% to 98%, measured at stable colonies (Hudson 1985, Sydeman 1993). Given that our study colonies represent relative extremes of population expansion and decline, it is not unreasonable to expect their survival rates to also be at the extreme ends of the normal range. Therefore, detection of a 4% difference with statistical significance should adequately address our primary hypothesis. To allow for a small percentage of known band loss, our goal is to individually mark a minimum of 200 birds of each species at each colony.

We were unable to complete our banding objectives during FY98 fieldwork (as detailed in the FY99 Restoration Project Annual Report). One of the local effects of 1998's El Niño

perturbation was markedly reduced attendance at our study colonies by both kittiwakes and murres. Furthermore, birds that did attend were unusually flighty and nervous, making them especially difficult to catch. Mainly due to these uncontrollable factors, we were not able to complete our target sample sizes of 200 marked birds of each species at each colony by 1998 (Table 2). By 1999, however, we had reached our target goals except for kittiwakes on Chisik Island. Kittiwakes remain difficult to capture owing to restricted access and the tendency for birds there to fail and desert nest-sites early in the season.

Furthermore, precise survival estimates based on banding are ideally generated by multi-year studies because long-lived seabirds often skip one or more years of attempts at breeding (Erikstad et al. 1995, Golet et al. 1998). Because of this, and also because returning birds are not always sighted in every year they come back to a colony (a function of observer effort and nest-site fidelity), it is desirable to have at least four years of re-sighting data for robust analyses of survival data (Pollock et al. 1990, Lebreton et al. 1992; W. Sydeman, pers. comm.).

We therefore proposed (and were funded for) an additional year of banding during summer 1999, necessitating an additional year of resighting fieldwork during summer 2000. The data analysis and writeup were projected into FY01. This extra year would boost our sample sizes into an optimal range, and allow for three years of resighting effort. However, it is clear that 4 years of resighting data are desirable for robust analyses of survival data (above), and we did not quite achieve our target sample size for kittiwakes on Chisik Island. We therefore propose to continue banding kittiwakes at Chisik in FY00, and conduct one more year of re-sighting in FY 2001. This would also allow us to continue coordination of survival studies with the study of physiological stress (EVOSTC Project 99479), which has continued funding for field work in FY01.

We are not asking for more funds to conduct this additional resighting work beyond what we had originally proposed for analysis and write-up in FY2001. The fall and winter of 2000-2001 will still be spent compiling survival data, analyzing it with respect to stress and food availability data, and preparing draft reports (at least introduction, methods, some results and preliminary conclusions). In May of 2001, we will do one more intensive re-sighting effort (re-sighting only, no banding or other bird work) to get the final (4^{th} year) of re-sighting with which to assess survival. We do not expect these data to change the main conclusions, rather to provide more robust statistical results. These results will be quickly incorporated into the final database, analyzed, and reported by September 2001. Any additional costs required for this effort will be covered by USGS.

Cooperating Agencies, Contracts, and Other Agency Assistance

Personal Services contracts may be used for statistical consultation and programming assistance.

SCHEDULE

A. Measurable Project Tasks for FY 01

Oct. 1-Jan. 31:	Evaluate results of FY00 work
Feb. 1-April 15:	Compile results from all years, analyze and initiate report
March:	Attend EVOS Symposium
April 15-May 30:	Last resighting effort on Gull and Chisik Is.
June 30-July 31:	Compile FY01 re-sighting results, analyze all 4 years data
Aug. 1- Sep. 15:	Complete report
Sep. 15:	Submit Draft Final Report to EVOSTC
Sep. 15- Dec. 31:	Completion and submission of papers for publication in peer-reviewed journals
Dec. 31:	Submit Revised Final Report to EVOSTC

B. Project Milestones and Endpoints

June 30, FY 01:	Resighting fieldwork will be completed
Dec. 31, FY02:	Final Report Complete and Submitted to EVOSTC
Dec. 31, FY02:	Submission of papers for publication in peer-reviewed journals

C. Completion Date

Our proposed research takes advantage of a natural comparative system (failing vs. thriving colonies) to reduce the time required to test the hypothesis that increased energy expenditure and stress during the breeding season will decrease adult survival. We propose three full field seasons of banding, re-sighting, and collection of productivity data (FY98, FY99, FY00) and one season of re-sighting only (FY01) to ensure an adequate sample size for robust analysis of survival. Efforts in FY01 and part of FY02 will focus on data compilation, analysis and publication of research results in peer-reviewed journals.

PUBLICATIONS AND REPORTS

The final planned product of the proposed research will be the final report detailing all findings, due on Sep. 15, 2001. Publication of project results in peer-reviewed journals will be pursued as soon as scientifically appropriate and logistically possible.

PROFESSIONAL CONFERENCES

Results of this project will be presented during FY02 at the Annual Meeting of the Pacific Seabird Group, or at other professional meetings where appropriate.

NORMAL AGENCY MANAGEMENT

This research would not be conducted as a normal part of USGS research on seabirds.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The proposed research issues are related to management and conservation of seabirds in Alaska as addressed by the U.S. Fish and Wildlife Service (USFWS) 'Seabird Management Plan' (USFWS Region 7, Migratory Bird Management). The proposed work will complement and be coordinated with: i) long-term studies conducted by the Alaska Maritime National Wildlife Refuge (AMNWR, USFWS Region 7), which includes annual monitoring of seabird productivity at 9 major seabird colonies throughout Alaska; ii) related studies (APEX) of seabird-forage fish interactions being supported by EVOSTC in Prince William Sound; and, iii) ongoing studies of seabird populations in areas of oil and gas development conducted by the Minerals Management Service (MMS) in Alaska and the Biological Resources Division of the USGS.

Logistic support from the USFWS and AMNWR will include vessel use, storage facilities, laboratory space, computer usage, and communications. Field sites and research platforms will be shared with the EVOSTC-funded APEX and sand lance projects.

EXPLANATION OF CHANGES IN CONTINUING PROJECT

The design of the proposed work has not changed. As explained above in 'Methods', however, banding efforts were extended by one year, and we propose one more re-sighting effort in FY01. This will give us 4 years of re-sighting data, greatly improving our ability to measure significant differences in survival of murres and kittiwakes at Gull and Chisik islands.

PRINCIPAL INVESTIGATOR

Dr. John F. Piatt
Alaska Science Center
USGS Biological Resources Division
1011 E. Tudor Road
Anchorage, AK 99503
tel. (907) 786-3549, fax (907) 786-3636
E-mail: john_piatt@usgs.gov

PRINCIPAL INVESTIGATOR

Dr. John F. Piatt, Research Biologist (GS-14) with the Alaska Science Center, Biological Resources Division, USGS in Anchorage. Obtained a Ph.D. in Marine Biology from Memorial University of Newfoundland in 1987 (dissertation on seabird-forage fish interactions). Since 1987, studied seabirds at colonies and at sea in Gulf of Alaska, Aleutians, Bering and Chukchi seas. Author on 75 peer-reviewed scientific publications about seabirds, fish, marine mammals, and effects of oil pollution on marine birds. Responsible for coordination and oversight of the proposed research.

PROJECT LEADER

Thomas I. Van Pelt, MSc. student at the University of Glasgow, Scotland, and current employee (GS-9) of the Alaska Biological Science Center. Over seven years of experience working in Gulf of Alaska and Aleutian marine ecosystems. Responsible for project design, logistics, data analysis, and preparation of manuscripts and reports.

OTHER KEY PERSONNEL

Ann Harding and Mike Shultz (USGS/BRD staff involved with APEX project) will share responsibility for fieldwork, data management and analysis, and manuscript preparation.

COLLABORATORS

Dr. Alexander S. Kitaysky, University of Washington, Dept. of Zoology. Will collaborate on project design and provide advice on methodology and analyses.

LITERATURE CITED

Aebischer, N.J. and J.C. Coulson. 1990. Survival of the kittiwake in relation to sex, year, breeding experience and position in the colony. Journal of Animal Ecology 59: 1063-1071.

Burger, A.E. and J.F. Piatt. 1990. Flexible time budgets in breeding Common Murres: Buffers against variable prey availability. Studies in Avian Biology 14:71-83.

Cairns, D.K. 1992. Population regulation of seabird colonies. Current Ornithol. 9:37-61.

Croll, D.A., A.J. Gaston, A.E. Burger, and D. Konnoff. 1992. Foraging behavior and physiological adaptation for diving in Thick-billed Murres. Ecology 73: 344-356.

Erikstad, K.E., T. Tveraa, and R.T. Barrett. 1995. Adult survival and chick production in long-lived seabirds: a 5-year study of the kittiwake *Rissa tridactyla*. Pp. 471-477 in: Ecology

of Fjords and Coastal Waters (Skjoldal, H.R., C. Hopkins, K.E. Erikstad, and H.P. Leinaas, eds.). Elsevier Science, London.

Golet, G.H., D.B. Irons, and J.A. Estes. 1998. Survival costs of chick rearing in black-legged kittiwakes. Journal of Animal Ecology 67:827-841.

Harris, M.P., and S. Wanless. 1988. The breeding biology of guillemots *Uria aalge* on the Isle of May over a six year period. Ibis 130:172-192.

Hatch, S.A., and J.F. Piatt. 1995. Seabirds in Alaska. *In*: Our Living Resources; National Biological Service, Report on Status and Trends of the Nation's Wildlife, Washington D.C. Pp. 49-52.

Hatch, S.A., B.D. Roberts, and B.S. Fadley. 1993. Adult survival of Black-legged Kittiwakes *Rissa tridactyla* in a Pacific colony. Ibis 135: 247-254.

Hatchwell, B.J. and T.R. Birkhead. 1991. Population dynamics of common guillemots *Uria aalge* on Skomer Island, Wales. Ornis Scandinavica 22: 55-59.

Heisey, D.M., and T.K. Fuller. 1985. Evaluation of survival and cause-specific mortality rates using telemetry data. Journal of Wildlife Management 49(3):668-674.

Hudson, P.J. 1985. Population parameters for the Atlantic Alcidae. *In*: The Atlantic Alcidae (D.N. Nettleship and T.R. Birkhead, eds.). Pp. 233-261.

Hunt, G.L., J.F. Piatt, and K.E. Erikstad. 1991. How do foraging seabirds sample their environment? Proceedings of the 20th International Ornithological Congress, 2-9 Dec., 1990, Christchurch, New Zealand, Vol. 4:2272-2279.

Irons, D.B. 1992. Aspects of foraging behavior and reproductive biology of the black-legged kittiwake. PhD. Dissertation, University of California, Irvine.

Kitaysky, A.S., J.C. Wingfield, and J.F. Piatt. 1999a. Dynamics of food availability, body condition and physiological stress response in breeding Black-legged kittiwakes. Functional Ecology 13:577-584.

Kitaysky, A.S., J.F. Piatt, J.C. Wingfield, and M. Romano. 1999b. The adreno-cortical stress-response of Black-legged Kittiwake chicks in relation to dietary restrictions. Journal of Comparative Physiology (B):303-310.

Lebreton, J.D., K.P. Burnham, J. Clobert, and D.R. Anderson. 1992. Modeling survival and testing biological hypotheses using marked animals: case studies and recent advances. Ecological Monographs 62:67-118.

Piatt, J.F. and P.J. Anderson 1996. Response of Common Murres to the *Exxon Valdez* Oil Spill and Long-term Changes in the Gulf of Alaska Marine Ecosystem. *In:* Rice, S.D., Spies, R.B., Wolfe, D.A., and B.A. Wright (Eds.). *Exxon Valdez* Oil Spill Symposium Proceedings. American Fisheries Society Symposium No. 18.

Pollock, K.H., J.D. Nichols, C. Brownie, and J.E. Hines. 1990. Statistical inference for capture-recapture experiments. Wildlife Monographs 107, 1-97.

Steel, R.G.D. and J.H. Torrie. Principles and procedures of statistics, 2nd Edition. McGraw Hill, 1980.

Sydeman, W.J. 1993. Survivorship of common murres on southeast Farallon Island, California. Ornis Scandinavica 24:135-141.

Zador, S., and J.F. Piatt. 1998. Time-budgets of Common Murres at a declining and increasing colony in Alaska. Condor 101:149-152.

Table 1. Power analysis of sample size (in a two by two table). One minus beta is power; a power of <0.50 is typical in survival estimations. One minus alpha is the confidence interval. Ps and Pe are estimated survival fractions at two hypothetical colonies. Thus, with a sample size of 47 (banded birds per colony), we would expect to resolve a 6% difference (Ps minus Pe) with a power of 0.51 and 90% confidence intervals. With a sample size of 185, we would expect to resolve a 4% difference with a power of 0.75 and 95% confidence intervals. In general, as sample size doubles, variance is halved (Heisey and Fuller, 1985). Resolution of differences <4% demands unacceptably large sample sizes.

alpha	Zalpha	beta	Zbeta	Ps	Pe	n =
0.10	1.18	0.25	0.68	0.92	0.89	352
0.10	1.18	0.49	0.01	0.92	0.89	226
0.05	1.65	0.25	0.68	0.95	0.91	185
0.05	1.65	0.25	0.68	0.95	0.90	125
0.10	1.18	0.25	0.68	0.95	0.90	100
0.10	1.18	0.49	0.01	0.94	0.89	72
0.10	1.18	0.49	0.01	0.95	0.89	47

Table 2. Number of birds color-banded by year, location, and species.

Year	Gull Island		Chisik Island	
	Murre	Kittiwake	Murre	Kittiwake
1996	0	9	0	0
1997	30	40	132	69
1998	101	108	56	71
1999	68	114	74	29
Total	**199**	**271**	**262**	**169**

Grand Total: 901 (Gull 470; Chisik 431)
Note: Not included in total are 30 murres and 40 kittiwakes banded on Gull in 1997, but experimentally manipulated.

2001 EXXON VALDEZ TR :E COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 1999	Proposed FY 2000						
Personnel		$41.0						
Travel		$0.0						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$41.0			Estimated FY2002	Estimated FY2003		
General Administration		$6.2						
Project Total	$0.0	$47.2			$0.0	$0.0		
Full-time Equivalents (FTE)		0.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Requested funds in FY01 for personnel only-- and slightly higher than projected cost last year ($46.4) owing to employee wage increases. Funds required for brief, intensive re-sighting effort in FY01 will be provided by USGS base funds. Estimated at about 10K for temporary Biotech and volunteers, 8K for travel, charters and transportation, 3K for supplies and boat maintenance,

FY01

Prepared: 04/13/00

Project Number: 01338
Project Title: Survival of Adult Murres and Kittiwakes
Agency: U.S. Geological Survey

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TF EE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FY 2000
Name	Position Description					
Thomas van Pelt	Wildlife Biologist	GS-9	10.0	4.1		41.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		10.0	4.1	0.0	
					Personnel Total	$41.0

Travel Costs:	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 2000
Description					
none					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

FY01

Prepared: 04/13/00

Project Number: 01338
Project Title: Survival of Adult Murres and Kittiwakes
Agency: U.S. Geological Survey

FORM 3B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed FY 2000
Description	
none	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed FY 2000
Description	
none	
Commodities Total	$0.0

FY01

Prepared: 04/13/00

Project Number: 01338
Project Title: Survival of Adult Murres and Kittiwakes
Agency: U.S. Geological Survey

FORM 3B
Contractual & Commodities DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2000
Description			
none			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number of Units	Inventory Agency
Description		

FY01

Prepared: 04/13/00

Project Number: 01338
Project Title: Survival of Adult Murres and Kittiwakes
Agency: U.S. Geological Survey

FORM 3B
Equipment
DETAIL

Prince William Sound Human Use and Wildlife Disturbance Model

Project Number:	01339
Restoration Category:	General Restoration & Habitat Protection
Proposer:	Chugach National Forest
Lead Trustee Agency:	USFS
Cooperating Agencies:	ADNR
Alaska SeaLife Center:	No
Duration:	One year
Cost FY01:	$ 24.1
Geographic Area:	Western Prince William Sound
Injured Resources/Service:	ALL (emphasis on: harbor seal, pigeon guillemot and cutthroat trout)

ABSTRACT

This project will support preparation and submittal of manuscripts for publication in professional journals. A manuscript will describe our use of geographic information system (GIS) techniques to describe current human-use patterns in western Prince William Sound and to model potential changes in those use patterns as a result of additional development (e.g., increased access). A second manuscript will document our use of the GIS generated maps of present and projected human-use patterns and their incorporation with GIS maps of the distribution of resources injured as a result of the *Exxon Valdez* oil spill. This effort provided a basis to identify areas where there may be existing and potential conflicts between human use and wildlife concentrations resulting in disturbance. Disturbance of injured wildlife may result in decreased productivity exacerbating the effects of the oil spill and prolonging the time to recovery. Identification of potential areas of disturbance allowed development of recommended management practices that may eliminate or minimize the negative effects of increasing human use. All injured resources and subsistence species will be addressed in a general approach but specific management recommendations will be provided for harbor seal, pigeon guillemot and cutthroat trout. The manuscripts describing the model of projected human-use patterns and the resulting process to develop management recommendations are expected to be useful to Federal, State, and private land managers in their land management planning efforts.

INTRODUCTION

The EVOS Trustee Council approved funding for a pilot project to develop a model of human use and wildlife disturbance in western Prince William Sound (PWS). That project provided a foundation for displaying and understanding existing and future human use patterns in PWS, the potential disturbances on injured resources, and made recommendations for management actions to minimize adverse effects of increased human use on injured resources. The project consisted of three components:

1. Development and evaluation of computer-generated spatial descriptions of existing human use patterns in PWS,
2. Development of a model to project changes in human use patterns as a result of development and management actions in western PWS, and
3. Identification of management actions for public lands to minimize potential future disturbance on injured resources.

In FY00 a final GIS representation of existing human use patterns in western PWS was developed. Obtaining information for this database was a collaborative effort with tremendous support from the Whittier Harbor, charter boat operators, and others. A GIS-based model for projecting future human-use patterns in western PWS has been completed and used to describe various development scenarios. This information has been combined with distribution patterns of harbor seal, pigeon guillemot and cutthroat trout and recommendations developed for their management. This proposal describes the work to be accomplished in Fiscal Year 01.

The final product of this project will be two manuscripts submitted for publication in professional journals. This project would provide publication of information useful in many aspects of the EVOS restoration program. The model would help in the identification of appropriate research and monitoring sites to understand the effects of human disturbance on specific injured resources or services. It would help in identifying areas where subsistence harvests may be affected by increased recreation and other uses. In addition to benefiting restoration activities, the model and recommendations would benefit State and Federal agencies, and the Chenega Corporation, in land management planning and in the protection of resources.

NEED FOR PROJECT

A. Statement of Problem

Human activity in PWS is expected to increase significantly in the next decade (ADOT 1995). This project provides publication of a management tool, and its application, that would increase the effectiveness of management of resources and human use in PWS. The project has direct application under Habitat Protection and General Restoration as described in the EVOS restoration plan (EVOS Trustee Council 1994), and has the potential to aid in the restoration of most of the identified injured resources and services.

B. Rationale/Link to Restoration

The Trustee Council has made significant progress in understanding the effects of the EVOS and in restoring and protecting the resources and services injured by the spill. However, the recovery of these resources and services may be affected by a dramatic increase in human use in PWS. The ADOT has predicted that the Whittier access road will result in an increase of over 600% in recreational and tourism boat traffic in parts of western PWS by the year 2015 (ADOT 1995). However, the Whittier road is only one of several changes that will affect human use in PWS. For example, in the last 5 years new glacier cruise tours have been established in Whittier, more State and Federal lands have been acquired in western PWS, and the number of recreational boaters in western PWS has increased. As more people recreate and work in PWS, there will be higher levels of interactions between people and injured resources. Research has shown that human disturbance can cause a wide range of problems for wildlife and fish populations. At its most severe levels, disturbance can cause mortality or reduced productivity (Knight and Cole 1991). As human use increases in PWS, the potential for problems related to human disturbance to delay recovery of injured species also increases. By identifying and publishing information on existing and potential human use patterns in western PWS, the Trustee Council would be providing a tool that would assist in habitat protection, general restoration, and would also provide valuable information for research and monitoring projects.

The work to be published took a broad-spectrum approach in describing potential disturbance patterns on injured resources and on subsistence species with a more in-depth analysis associated with three injured species: harbor seal, pigeon guillemot and cutthroat trout. This analysis compared known distribution patterns of these species with the predicted disturbance patterns to provide more specific management recommendations. Harbor seals were selected because tourism and recreational boats often approach their haulout sites. Richardson et al. (1995) provided a summary of effects of disturbance at haulout sites; such disturbance can result in site abandonment, shifts to nighttime haulout schedules, or injury and increased pup mortality. Pigeon guillemots are susceptible to human disturbance during nesting because they nest on or near beaches that may also provide good campsites and fishing areas for people. Of sportfish species, cutthroat trout may be at the greatest risk. PWS is the northern-most extent of the range for this species. Populations in western PWS are generally small and poorly understood. Increased harvest of this species could further reduce the population (Dan Gillikin, pers. com.).

C. Location

This project focused on western PWS. The project will benefit all State and Federal agencies with management responsibilities in PWS. The project will also benefit other landowners, especially the Chenega Corporation and the community of Chenega Bay.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Involvement from the community of Chenega Bay and from the Chenega Corporation was an important component of this project. In order to fully understand human-use patterns in western PWS, the human use patterns to and from Chenega Bay were incorporated into the model. The

Chenega Corporation cooperated on this project by supplying information on historical and current use patterns, and by commenting on the predicted human use patterns identified by the model. Residents of Chenega Bay participated by identifying activity patterns near the village and in southwestern PWS.

PROJECT DESIGN

A. Objectives

The objectives associated with this project include development and submittal of the following manuscripts:

Development of a model of human-use patterns in western Prince William Sound to evaluate effects of disturbance on wildlife, and

Managing to protect sensitive wildlife in western Prince William Sound through evaluation of human-use patterns.

B. Methods

The manuscript "**Development of a model of human-use patterns in western Prince William Sound to evaluate effects of disturbance on wildlife**" will be submitted to *Biological Conservation.* The manuscript will report on our use of GIS techniques to describe current human-use patterns in western Prince William Sound and to model potential changes in those use patterns as a result of additional development (e.g., increased access). Current human-use patterns were constructed from numerous sources, including 1) information gathered from surveys of boaters using the area of interest, 2) records of use of harbors, 3) interviews with and records of charter boat operators, and 4) information from State of Alaska on commercial and sport fishing use. Resulting use patterns were verified and refined through aerial surveys during the 1998 boating season. Potential changes in those use patterns were described from information gathered from the user surveys and other projections of changes in human-use patterns. The spatial and temporal descriptions of current and future human-use patterns provided by this model have proved useful in managing to protect populations of sensitive wildlife and to distribute wildlife harvest effort.

The manuscript "**Managing to protect sensitive wildlife in western Prince William Sound through evaluation of human-use patterns** will be submitted to the *Wildlife Society Bulletin.* In this manuscript we will describe current and historic spatial distribution of wildlife species potentially sensitive to human disturbance in western Prince William Sound through GIS techniques. Emphasis will be placed on those species injured as a result of the *Exxon Valdez* oil spill. We incorporated that information with a GIS-based model of current and potential human-use patterns. This provided a basis to identify areas where there may be existing and potential future conflicts between human use and wildlife concentrations resulting in disturbance. Disturbance of injured wildlife may result in decreased productivity, exacerbation the effects of the oil spill and prolonging time to recovery. Identification of potential areas of disturbance allowed development of recommended management practices that may eliminate or minimize

the negative effects of increasing human use. As a result of this work, specific management recommendations were developed for harbor seal, pigeon guillemot, and cutthroat trout. This information is expected to be useful to Federal, State, and private land managers in their land management planning efforts.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The State of Alaska, Department of Natural Resources is a partner on this project; Forest Service personnel will be responsible for the development and submittal of manuscripts.

SCHEDULE

A. Measurable Project Tasks for FY01

Oct. 1-Dec 31:	Preparation and review of manuscripts
Jan 15:	Submission of manuscripts to journal editors
May 1:	Final revision of manuscript (anticipated)
July 1:	Acceptance of manuscripts for publication (anticipated)

B. Project Milestones and Endpoints

Oct. 1-Dec 31:	Preparation and review of manuscripts
Jan 15:	Submission of manuscripts to journal editors
May 1:	Final revision of manuscript (anticipated)
July 1:	Acceptance of manuscripts for publication (anticipated)

C. Completion Date

This project will be completed in FY 2001.

PUBLICATIONS AND REPORTS

The final manuscripts for this project will be completed in July 2001.

PROFESSIONAL CONFERENCES

The principal investigators will have presented this work at The Wildlife Society national conference in FY00.

NORMAL AGENCY MANAGEMENT

This project is outside the scope of normal management for the Chugach National Forest. Development of human dispersion models similar to the proposed project has not been done previously in the context of National Forest management. The Forest Service has conducted public use surveys in 1992 and 1995 on the Chugach National Forest to provide information for the Forest Plan Revision process. Additional surveys are not planned for PWS. This project is also outside of normal agency management because of the combination of species being addressed. Populations of species injured by the EVOS are potentially some of the most vulnerable to disturbance associated with increased human use. Many of these species, such as harbor seals, rarely occur on National Forest land; however, activities and management associated with National Forest land can affect these marine species.

Ultimately, managing human use in PWS will be an interagency responsibility, which will require coordination between multiple agencies. This project will provide useful information for all of these agencies.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Opportunity exists to integrate this project with many of the other restoration projects. During the work to be reported here, three of the principal investigators who work with harbor seals, pigeon guillemots, and cutthroat trout were contacted. All three agreed to cooperate with this project to facilitate the emphasis on management of these species. The primary principal investigator for the APEX project also identified opportunities to link the dispersion model to GIS data layers on forage fish densities, and seabird foraging and nesting areas. The combination of the human dispersion model and the model developed through APEX would provide important insights into managing seabird populations.

The work reported here will also be integrated into State and Federal agency management and will provide useful information to the Chenega Corporation and Chenega Bay in their ecotourism development plans for PWS. The Chugach National Forest will be continuing the revision of the 10-year Forest Plan during FY01. The information reported will be incorporated into the Forest planning process. Although the Forest Plan revision effort is anticipated to be completed before these manuscripts would be finalized, the principal investigator will work with the planning team to provide relevant information. The model and recommendations described in the manuscripts will also benefit biologists and recreation specialists who make project-level decisions for the Chugach National Forest. It is anticipated that other Federal agencies, such as National Marine Fisheries Service, will benefit from the work reported in these manuscripts in their management activities.

The Alaska Department of Natural Resources is a partner on this project. This partnership will ensure that kinds of activities undertaken by State agencies are addressed in the manuscripts and that the product would be beneficial to the State of Alaska.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This proposal has changed from the project proposals submitted for FY98, FY99, and FY00 in that preparation of manuscripts for publication in professional journals was not included in those proposals.

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

Lowell H. Suring

Lowell H. Suring received his M.S. in wildlife science from Oregon State University in 1974. His thesis involved assessing habitat use and activity patterns of the endangered Columbian white-tailed deer. This work lead to co-authorship of two major scientific publications. Lowell was leader of the Endangered Species and Wildlife Biometrics units in New York State from 1974 through 1977. In 1977 and 1978 he conducted research on secondary succession patterns in pinyon-juniper woodlands in northwest Colorado. From 1978 to 1984 Lowell held biologist positions with the Fish and Wildlife Service and Forest Service in New Mexico and Minnesota where he was involved with determining wildlife habitat relationships and the assessment of effects of management actions on wildlife habitats and populations. Since 1984, Lowell has been a primary participant in the development of GIS-based wildlife habitat relationships and cumulative effects models in the Alaska Region of the Forest Service. Lowell's professional expertise and interests focus on analyzing habitat-use patterns of wildlife and the development and application of computer-based habitat assessment techniques. He has authored or co-authored more than 30 technical and semi-technical articles describing accomplishments in these areas. Currently, Lowell is employed by the Chugach National Forest where he is implementing analytic techniques and tools that may be used to evaluate the capability of habitats to support wildlife and the effects of land management activities on habitat capability. To support these efforts he has had extensive training and experience in the application of ESRI's ARC/INFO geographic information system.

LITERATURE CITED

Alaska Department of Transportation and Public Facilities. 1995. Whittier access project, revised draft Environmental Impact Statement and revised draft Section 4(f) Evaluation, May 1995. FHWA-AK-EIS-94-02-DR

Knight, R. L. and D. N. Cole. 1991. Effects of recreational activity on wildlife in wildlands. Trans. N.A. Wildl. and Nat. Res. Conf. 56:238-246.

Richardson, W. J., C.R. Greene Jr., C. I. Malme, and D. H. Thomason. 1995. Documented disturbance reactions. Pages 241-322 *in* Marine Mammals and Noise. Academic Press. San Diego.

2001 EXXON VALDEZ TRI : COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001	LONG RANGE FUNDING REQUIREMENTS					
						Estimated FY 2002		
Personnel	$12.2	$19.2						
Travel		$0.0						
Contractual		$0.0						
Commodities		$2.0						
Equipment		$0.0						
Subtotal	$12.2	$21.2						
General Administration	$1.8	$2.9						
Project Total	$14.0	$24.1						
Full-time Equivalents (FTE)		0.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: Publication of two manuscripts

FY01

Prepared: 4/11, KEH

Project Number: 01339
Project Title: Western PWS Human Use & Wildlife Disturbance Model Publications
Agency: US Forest Service

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRI : COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
L. Suring	Wildlife Biologist	GS-12	3.0	6.4		19.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		3.0	6.4	0.0	
					Personnel Total	$19.2

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

FY01

Prepared:

Project Number: 01339
Project Title: Western PWS Human Use & Wildlife Disturbance Model Publications
Agency: US Forest Service

FORM 3B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRI : COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

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

Commodities Costs:	Proposed FY 2000
Description	
Publication Costs (2)	2.0
Commodities Total	$2.0

FY01

Prepared:

Project Number: 01339
Project Title: Western PWS Human Use & Wildlife Disturbance Model Publications
Agency: US Forest Service

FORM 3B
Contractual & Commodities
DETAIL

2001 EXXON VALDEZ TRI E COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

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

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

FY01

Project Number: 01339
Project Title: Western PWS Human Use & Wildlife Disturbance Model Publications
Agency: US Forest Service

FORM 3B
Equipment
DETAIL

Prepared:

Toward Long-Term Oceanographic Monitoring of the Gulf of Alaska Ecosystem

Project Number:	01340
Restoration Category:	Monitoring
Proposer:	University of Alaska Fairbanks
Lead Trustee Agency:	ADFG
Cooperating Agencies:	none
Alaska SeaLife Center:	no
Duration:	4rd year, 4-year project
Cost FY 01:	$67,321
Geographic Area:	Resurrection Bay/Gulf of Alaska shelf
Injured Resource/Service:	All organisms and services

ABSTRACT

Interannual variations in Gulf of Alaska shelf temperature and salinity could significantly influence this ecosystem and hence the recovery and restoration of organisms and services affected by the *Exxon Valdez* oil spill. This variability is best quantified from time series such as the 30-year record at hydrographic station GAK1 near Seward. This project continues this sampling and quantifies this variability. It also attempts to establish relationships between Seward sea level and shelf salinity and regional atmospheric pressure patterns and discharge variability. The data and the analyses will aid in designing a cost-effective ecosystem-monitoring program.

INTRODUCTION

This is a continuation proposal describing the fourth of a proposed four-year effort to maintain the 30-year time series of conductivity-temperature versus depth (CTD) data collected at hydrographic station GAK1. EVOS support for this program began in November 1997 with monthly cruises to station GAK1. These are continuing through September 2000. The monthly data are being supplemented with hourly (or shorter) measurements of temperature and conductivity at six depths using instruments moored at station GAK1. Weingartner (1999, 2000) gives a more complete description and analysis of the data collected thus far. However, the findings thus far indicate:

1. The anomalous summer 1997 warming (amounting to 1-2°C above normal) was confined to the upper 40 m of the ocean. That warming was mainly a result of anomalously clear skies and low winds during the summer of 1997.
2. The abnormally large El Niño-related winter 1998 warming (~2°C) occurred throughout the entire 250 m depth of the shelf. The return to near normal temperatures beginning last May and continuing through the present is being documented.
3. The abnormally large El Niño-related winter 1998 freshening (amounting to a vertically averaged salinity decrease of 0.15 psu) over the upper 200 m of the shelf. Freshening ceased in May and, below 200 m, was replaced with the saltiest waters ever observed at this location. These high salinity waters are enriched in nutrients and potentially available to phytoplankton in the surface layers.
4. A return to near normal temperatures after May 1998 which has continued.
5. The integral time scales for temperature and salinity at GAK1 are about 1 month, which implies that the monthly values (which comprise the historical data set) are not severely aliased.
6. Within-month temperature and salinity variance computed from the moored instruments is no greater than the interannual variability based on the monthly data from the historical record.
7. Variations in freshwater forcing and the baroclinic transport of freshwater are large on seasonal, interannual, and interdecadal time scales. On average freshwater transport increases fivefold between spring and fall. Alaska Coastal Current freshwater transport in spring 1998 (during the 1997-98 El Niño) was twice that of spring 1999.
8. The alongshore baroclinic transport in the upper 75m of the water column and within 30 km of the coast carries at least 50% of the total coastal discharge (as estimated by Royer, 1982) into the Gulf of Alaska.
9. The Alaska Coastal Current could significantly influence the marine ecosystem on the southeast Bering Sea. Our preliminary estimate is that the Alaska Coastal Current contributes about 25% of the Bering Sea freshwater supply. Therefore, improved understanding of environmental variability of the Gulf of Alaska ecosystem could improve our understanding of changes in the Bering Sea ecosystem.
10. Time series of coastal discharge estimates based on Royer's (1982) method, measured discharge, the leading EOF of precipitable water over the Northeast Pacific Ocean, and coastal salinity data all suggest a decrease in freshwater discharge into the northern Gulf of

Alaska from the late 1950s through the mid-1970s. Discharge increased from the mid-70s through the early-80s; coincident with the regime shift of the 1970s and with the PDO (Mantua, 1997; Overland et al., 1999). These findings add to other suggestions of a freshening across the North Pacific Ocean basin since the 1970s (Wong et al., 1999).

11. Monthly anomalies in the PDO index are coherent with Royer's monthly discharge anomalies at periods of 2 - 4 years and might be related to El Niño events.

12. Monthly sea level anomalies at Seward Alaska are significantly correlated with monthly anomalies of vertically integrated (0-200m) salinity and the 0/200db dynamic height. Hence sea level could serve as a proxy for shelf salinity variations here and perhaps elsewhere in the Gulf of Alaska. The Gulf of Alaska watershed and coastal ocean are severely undersampled with respect to precipitation, river discharge, and salinity. Long-term time series of these are lacking and even the future maintenance of existing discharge and weather stations is uncertain. There is a need to develop proxy variables that can be used to reliably estimate runoff and coastal salinity. A goal of this EVOS program is to determine if sea level can serve as a proxy for ocean salinity variations.

This program will continue the measurements at GAK1 and will continue examining other existing data sets with a particular focus on understanding the temporal and spatial variability in precipitation and runoff related to item 9.

The GAK1 environmental data appear representative of conditions in the northern Gulf of Alaska and the Bering Sea (Royer, 1993) and are being used to assess the role of environmental variability in the ecology of fisheries and marine mammals in these regions. Station GAK1 lies in 260 m of water at the mouth of Resurrection Bay, midway between Prince William Sound and Cook Inlet (Figure 1). GAK1 data should be helpful in placing many of the restoration studies sponsored by the Trustee Council in the context of interannual and interdecadal hydrographic variability. These data complement the goals of the Gulf of Alaska component of the U.S. Global Ocean Ecosystem Dynamics program (GLOBEC), which began in October 1997. As a PI on the Gulf of Alaska GLOBEC program, I have shared data (and sampling resources) from both programs to build a better understanding of the physical environmental variability of this shelf. GLOBEC is supported by the National Science Foundation (NSF) and the National Oceanic and Atmospheric Administration (NOAA). It consists of three components: monitoring, process studies, and modeling. Monitoring began in the Gulf of Alaska in October 1997, with modeling and process studies to follow in 2001. The proposal described here will encourage synthesis of the ecosystem studies supported by the Trustee Council and GLOBEC. In the following paragraphs we summarize the regional oceanography and the historical data from GAK1. This background information provides the context for understanding the rationale and the design of the project described in subsequent sections.

The circulation on the shelf and over the slope of the Gulf of Alaska is predominantly alongshore and cyclonic (counterclockwise) on average (Reed and Schumacher, 1986). Along the continental slope the flow consists of the Alaska Current, a relatively broad, diffuse current in the north and northeast Gulf which intensifies to become the swift and narrow western boundary current, the Alaskan Stream, in the west and northwest Gulf (Figure 2). Together these currents compose the poleward limb of the North Pacific Ocean's subarctic gyre and provide the oceanic connection between the Alaskan shelf and the Pacific Ocean.

The Alaska Coastal Current is the most striking shelf circulation feature in the Gulf, and station GAK1 is positioned along its inshore edge. The main axis of this swift (0.2–1.8 m s^{-1}) westward-flowing current is within 35 km of the coast (Royer, 1981; Johnson et al., 1988; Stabeno et al., 1995). The coastal current is a perennial feature that circumscribes the Gulf of Alaska shelf for some 2500 km (at a minimum) from its origin on the northern British Columbia shelf (or possibly even the Columbia River depending on the season) to where it enters the Bering Sea in the western Gulf. The current is intimately connected to Prince William Sound, feeding the Sound through Hinchinbrook Entrance and draining it primarily through Montague Strait and the westernmost passes (Niebauer et al., 1994). It is also the source of shelf waters for Cook Inlet and transports inlet waters southwestward through Shelikof Strait (Muench et al., 1981). The Alaska Coastal Current transported much of the oil spilled by the *Exxon Valdez* along the south and west coasts of Alaska (Royer et al., 1990).

The dynamics of the Gulf of Alaska shelf are closely coupled to the Aleutian Low atmospheric pressure system. Storms propagate eastward into the Gulf and are blocked by the mountain ranges of Alaska and British Columbia. Consequently, regional winds are strong and cyclonic and precipitation rates are very high. On the shelf, these winds impel an onshore surface Ekman drift and establish a cross-shore pressure gradient that forces the Alaska Coastal Current. The high rates of precipitation, up to 8 m yr^{-1}, cause an enormous freshwater flux (~20 % larger than the average Mississippi River discharge) that feeds the shelf as a "coastal line source" extending from Southeast Alaska to Kodiak Island (Royer, 1982). The seasonal variability in winds and freshwater discharge (**Figure 3**) is large. (Winds are represented in **Figure 3** as the upwelling index, a measure of the strength of cyclonic wind stress in the Gulf. Negative values mean coastal convergence and downwelling while positive values signify coastal divergence and upwelling. With respect to Alaska's south coast, negative values westward winds and positive values). The mean monthly "upwelling index" at locations on the Gulf of Alaska shelf is negative in most months, indicating the prevalence of coastal convergence. Cyclonic winds are strongest from November through March and feeble or even weakly anticyclonic in summer when the Aleutian Low is displaced by the North Pacific High (Royer, 1975; Wilson and Overland, 1986). The seasonal runoff cycle (**Figure 3**) exhibits slightly different phasing from the winds: it is maximum in early fall, decreases rapidly through winter when precipitation is stored as snow, and attains a secondary maximum in spring due to snowmelt (Royer, 1982).

The shelf hydrography and circulation vary seasonally and are linked to the annual wind and freshwater discharge cycles. **Figure 4** contrasts the cross-shore salinity structure in April, July, and December. (Density gradients are important in ocean dynamics and salinity is the predominant influence on ocean density in the Gulf of Alaska.) In April, the vertical and cross-shore density gradients are weak and the front (~10 km offshore) intersects both the surface and the bottom. In July, the vertical density gradients are strong and the cross-shore density gradients are relatively strong. Now the front is confined to the surface and has spread ~40 km offshore. In December, the stratification is moderate, the cross-shore density gradients are large and the front forms a 30-km wide wedge adjacent to the coast. These different frontal structures imply seasonally varying dynamics (e.g., Yankovsky and Chapman, 1997; Chapman and Lentz, 1995) that affect the transport and dispersal of dissolved and suspended material across the shelf. For example, surface drifters released seaward of the ACC drifted onshore (in accordance with Ekman dynamics). Upon encountering the ACC front, they moved in the alongfront direction, which is consistent with the geostrophic tendency implied by the cross-shore density distributions of **Figure 4** (Royer et al, 1979). Inshore of the ACC front, the surface layer spreads offshore as

discharge increases (Johnson et al., 1988). This cross-shelf circulation pattern could accumulate plankton and attract foraging fish. **Figure 4** also shows that near-bottom salinities are higher in summer than in spring and, in fact, maximum bottom salinities occur in fall coincident with minimum surface salinities and maximum inshore stratification (Xiong and Royer, 1984). The source of the high salinity water is the onshore intrusion of slope water when downwelling relaxes in summer (Royer, 1975, 1979). Simple 2-D models of this shelf suggest that the dense water is mixed upward in winter to supply the surface layers with nutrients in early spring (Williams and Weingartner, 1999). The swiftest along shore flows are found within and inshore of the front (Johnson et al., 1988), and most of the total transport is associated with the baroclinic component (Stabeno et al., 1995). The latter result is consistent with the finding that monthly coastal sea level anomalies at Seward are significantly correlated with upper ocean dynamic height and vertically averaged salinity anomalies at GAK1 (Weingartner et al., 2000). Dynamic height is a function of the vertically integrated ocean density. Horizontal gradients of dynamic height are proportional to the pressure gradients that accelerate ocean currents and provide an estimate of the oceanic transport. These findings are remarkable given the different nature of the sampling techniques: the sea level records were sampled hourly and then averaged into monthly means whereas the dynamic heights were from hydrographic measurements at GAK1 occupied several months apart. Royer (1979) also found that sea level and precipitation anomalies were well correlated.

The foregoing results suggest that there might be a relationship between monthly (and perhaps shorter period) *cross-shelf dynamic height (or upper ocean density) gradients* and a number of other variables including winds and/or freshwater discharge. Under GLOBEC support we are finding that there is a significant positive correlation between monthly anomalies in 0/100 db Alaska Coastal Current baroclinic transport and inner shelf (eventually GAK1) dynamic heights. The relationship appears to vary seasonally (although the number of degrees of freedom is small in some seasons): it is largest in fall and early spring ($r > 0.8$), negligible in summer, and negative in winter. Although these findings are promising I do not understand the seasonal changes in the correlations. I suspect that, if real, the seasonally changing correlation is related to the coastal current's response to seasonal changes in winds and discharge. That response is probably not linear. Nevertheless, if a reliable relationship can be constructed between GAK1 dynamic height and Alaska Coastal Current transport, then it might be possible to predict mass and freshwater transports (on at least monthly or longer time scales) from a single hydrographic station or mooring on the inner shelf. We also know that freshwater discharge (Royer, 1982; Weingartner et al., 2000) and winds (Livingstone and Royer; 1980) are coherent over a broad along shore distance. In addition, the integral time scales of temperature and salinity (calculated from the EVOS-supported mooring at GAK1, Weingartner, 1999), are about one month on this highly advective shelf. Because of the broad spatial scales and the long integral time scales it might be possible to construct one or two monitoring sites around the gulf that are representative of a broad along shore region of the shelf. If so the results would be useful for ecosystem monitoring, model evaluation (and perhaps data assimilation) and in retrospective studies.

It is very likely that transport variations in the Alaska Coastal Current affect the survival and/or condition of a number of marine organisms. This flow is apparently important in advecting zooplankton to important juvenile fish foraging areas. Napp et al. (1996) and Incze and Ainaire (1994) find that the major cohort of naupliar stage larvae available to first-feeding pollock larvae in Shelikof Strait originate in February–March on the shelf offshore of Prince William Sound and east of GAK1. Other studies indicate that the coastal current is an important feeding and

migratory corridor for numerous species of marine mammals (Calkins, 1986) and sea birds (DeGange and Sanger, 1986).

Figure 4 also suggests that near-bottom salinities are higher in fall than in spring and this is the case on annual average. Xiong and Royer (1984) showed that maximum bottom salinities occur in fall and are nearly coincident with minimum surface salinities and maximum inshore stratification (**Figure 5**). Although surface waters are diluted by coastal discharge (which peaks in fall), the source of the high salinity water is the onshore intrusion of slope water in response to the seasonal relaxation (or reversal) in downwelling (Royer, 1975; 1979). The deep-water influx in summer from across the continental slope could be important in re-supplying nutrients to the Gulf of Alaska shelf and adjacent embayments and therefore, plays an important role in biological production.

The oceanographic description sketched above stems from research that began in 1970. At that time research vessels from the University of Alaska and other organizations opportunistically sampled station GAK1 while in transit to and from the Seward Marine Center. This ad hoc sampling, conducted at nominally monthly intervals, was the beginning of what is now a 30-year time series for this station. Sampling became more routine (~monthly) in the early 1990s with support from NOAA and the use of a 25-foot vessel operated by the University of Alaska's Institute of Marine Science. EVOS support has systematized the sampling further and the mooring is yielding crucial new information on temporal variability in the thermohaline structure of this shelf. As a result of these efforts the GAK1 data set comprises the longest ocean time series for the high-latitude North Pacific Ocean, and the only one that includes salinity (Royer, 1993). These data reveal substantial interannual and decadal scale variability in both temperature (Royer, 1993) and salinity (Royer, 1996).

For example, Royer (1993) showed pronounced interdecadal temperature variations that included colder water in the 1970s, followed by warmer conditions in the 1980s and a return to normal or cooling conditions in the 1990s. Coincidentally, the relative dominance of commercially important fish species changed in the mid-1970s; crab and shrimp declined while salmon and groundfish populations increased (Albers and Anderson, 1985; Blau, 1986; Hollowed et al., 1994; Thompson and Zenger, 1994; Francis and Hare, 1994). These population shifts coincided with the beginning of a decadal North Pacific change in the atmosphere and ocean (Trenberth and Hurrell, 1994). Subsequent changes in this ecosystem followed in the 1980s with substantial declines in populations of sea lions (Merrick et al., 1987) and puffins (Hatch and Sanger, 1992). Vance et al. (1998) showed that the unusually warm surface waters prevalent throughout the Gulf of Alaska and the Bering Sea in the summer of 1998 were accompanied by observations of species typically associated with mid-latitudes and, in the case of the Bering Sea, with massive changes in the ecosystem.

Royer (1993) also showed that Sitka air temperature variability (for which records extend back to the mid-1800s) correlates with the GAK1 temperature anomalies at 200 and 250 m depths. He found that the 18.6-year lunar nodal tide accounts for a statistically significant fraction of the Sitka air temperature variability. Using the Sitka air temperatures as a proxy for shelf water temperatures, Parker et al. (1995) subsequently showed that the abundance of halibut and other commercially important species varies on a similar time scale and in conjunction with northern

North Pacific Ocean temperatures. While these correlations do not imply causality, they underscore the possible significance of monitoring ocean climate to detect both periodic changes and more radical shifts in the marine environment. Other EVOS-supported investigators studying murre nesting variability (Kettle et al., 1999) have used the data collected recently at GAK1. Other EVOS investigators have showed that warm ocean temperatures enhance survival of young-of-the-year salmon (Willette et al., 1999) and overwintering herring (Norcross et al., 1999). Conceivably the GAK1 record might eventually be used in management decisions.

There are also low-frequency variations in upper ocean salinities at what might be an 11–12 year period, which Royer (1996) ascribed to variations in runoff and precipitation. Much of the interannual variability in precipitation in the Gulf of Alaska is associated with changes in the strength and position of the Aleutian Low (Cayan and Peterson; 1989). Weingartner et al. (2000) also show that much of the low frequency variability is coherent with the Pacific Decadal Oscillation at periods of 2 – 4 years (the El Niño time scale). Changes in upper ocean salinity could affect circulation in the Alaska Coastal Current and also influence biological production by varying frontal properties, circulation strength, the vertical stratification of the water column, and the nutrient concentrations. All of these properties showed considerable differences during the fresh, warm spring of 1998 compared to the salty (but near normal temperatures) of spring 1999 (Weingartner, 2000). The GAK1 data also show substantial interannual variations in bottom water salinities, although these are not linearly correlated with variations in surface salinity. The absence of a correlation is not surprising because near-bottom salinities are linked to shelfbreak processes, while surface variations are associated with precipitation and runoff. Ruehs et al. (1999) are finding that salinity and NO_3 concentrations are positively correlated (**Figure 6**) so that variability in deep water salinity on the shelf probably mean interannual differences in nutrient supply. The GLOBEC program is providing a detailed and year-round description of the nutrients on the Gulf of Alaska shelf. As the amount of these data increase more reliable salinity–nutrient relationships can be established. If these are robust then it might be possible to use the GAK1 salinity time series as a proxy for subsurface nutrient concentrations. This relationship could be exploited in retrospective studies and would aid in the design and maintenance of future monitoring programs because salinity can be accurately measured much more easily (and inexpensively) than nutrients.

In summary, several data sets now suggest that the Gulf of Alaska ecosystem is sensitive to environmental variations on time scales ranging from interannual to interdecadal. Other data sets suggest possible biophysical linkages that cause these ecological responses. However, we lack an adequate characterization of shorter period (seasonal to synoptic) variations that might impinge on the biological components of this ecosystem. Moreover, a mechanistic understanding of the physical dynamics of the Gulf of Alaska shelf and the processes linking environmental variability to ecosystem alterations is lacking. These are complex problems that require a concerted and interdisciplinary approach involving process-specific studies in addition to ecosystem monitoring. Some of these programs (APEX and SEA) are sponsored by the Trustee Council, while a new initiative, the U.S. Global Ocean Ecosystem Dynamics program, began in the fall of 1997 on the Gulf of Alaska shelf. The GLOBEC program is specifically designed to elucidate details of the mechanisms underlying physical and biological environmental change on the shelf. For example, the nutrient cycles and concentrations on the Gulf of Alaska shelf are poorly understood at present (Reeburgh and Kipphut, 1986) but are being investigated in the GLOBEC program. Those results should benefit the monitoring proposed herein. In tandem, the GLOBEC- and Trustee-supported efforts will lead to improvements in ecosystem monitoring.

While the GAK1 time series has illuminated ocean variations having potentially significant ramifications for the marine ecosystem, the monthly sampling will not detect what might be important variations on shorter time scales. Present-day technology now allows inexpensive and accurate sampling at high temporal resolution of temperature and salinity from moorings deployed year round. In combination with monthly CTD sampling, this technology will enhance the value of the historical record, maintain the GAK1 time series, and contribute to the design of long-term ecosystem monitoring programs. The collection of these data forms the basis of this proposal.

NEED FOR THE PROJECT

A. Statement of Problem

The GAK1 monthly time series portrays the very large interannual and interdecadal variability of the high latitude North Pacific. With a greater sampling rate, shorter period variations can be detected, revealing any temporal aliasing problems. The results will enhance interpretations of the historical data and place the magnitude of previous anomalies in a better statistical framework. Moreover, the time series could serve as a proxy for transport in the Alaska Coastal Current. Variability in the marine environment, as reflected in ocean temperatures and salinities, and, if possible, shelf circulation, need to be quantified to understand the structure of, and changes in, the northern Gulf of Alaska marine ecosystem. Such changes might influence the recovery of many of the marine species and marine services listed in Table 4 of the Proposal Invitation. Indeed, several EVOS-supported investigators underscored the need to understand natural climate variability and its influence on the recovery of species injured by the oil spill (Purcell et al., 1999; Piatt and Irons, 1999; Duffy, 1999; Anderson et al., 1999). In conjunction with the historical data set from GAK1, the monitoring program described below will provide a useful data set to EVOS investigators and others concerned with ocean climate variations.

B. Rationale/Link to Restoration

This monitoring proposal provides an information service to current and future investigators working in the Gulf of Alaska and adjacent waters who need information on environmental variability. The information will help assess recovery and restoration progress by allowing these issues to be analyzed within the context of the long-term variability of the physical environment. The GAK1 data set provides some of that information and the proposed measurements will enable continuation of these efforts by collecting time series at GAK1 of:

1. Monthly temperature and salinity at every meter throughout the water column using a conductivity–temperature–depth (CTD) instrument.

2. Hourly temperature and salinity at several fixed depths distributed throughout the water column.

This information will assist in:

1. Understanding thermohaline variability on time scales ranging from the tidal to the interdecadal.

2. Interpreting historical data sets for use in retrospective studies.

3. Configuring a cost-effective, long-term monitoring program.

4. Designing process studies necessary to develop ecosystem models for this shelf.

C. Location

The fieldwork will be conducted at Station GAK1 at the mouth of Resurrection Bay. Both the CTD work and the mooring deployment and recovery operations will be conducted from the Seward Marine Center using the 25-foot vessel, *Little Dipper*. All data collected as part of this program will be available to any who desire it via files on the internet. The monthly CTD data will be combined with the existing historical data that are on the Institute of Marine Science webpage: http://www.ims.alaska.edu:8000/gak1/gak.dat. A new homepage will be created for the hourly time series after mooring recovery and editing of the data. The homepages will be linked.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

We do not see any overt connection to traditional ecological knowledge. However, the most expedient way to share these data with both the public and scientific communities is via the internet. Such a link will allow easy access to the data for those working at the community level and with traditional ecological knowledge. We have recently learned that the Alaska Department of Environmental Conservation (ADEC) maintains a VHF radio repeater on Rugged Island and within 1.5 miles of GAK1. The ADEC has indicated that the repeater station could be shared with other users. If technical obstacles can be overcome, we will seek to upgrade GAK1 so that data collected from this mooring could be transmitted, via VHF signal, in near real time directly into Seward (preferably the Alaska SeaLife Center) for immediate use and display. A VHF transmission would be considerably cheaper than data links via ARGOS or cell phone.

PROJECT DESIGN

A. Objectives

Two objectives motivate this multi-year program. First, we want to continue the 30-year time series at station GAK1 through a combination of monthly CTD measurements and through yearlong deployments of a mooring containing temperature and conductivity (T/C) recorders. Second, we want to contribute to the design of a cost-effective monitoring program for the Gulf of Alaska shelf. The sampling schemes complement one another with one providing high vertical resolution at monthly time scales and the other providing high temporal but relatively low vertical resolution. We recognize that our generic goal of ecosystem monitoring is a long-term undertaking requiring incremental efforts and so view our efforts as essential steps toward that goal. To guide our efforts we formulated several project-specific objectives, several of which are

underway, and discussed them in the first and second year's annual reports (Weingartner, 1999; 2000). These are:

1. Determine the rate of change of water mass properties (temperature and salinity) and the phasing of these changes at different depths. Some of these features, which are not resolved by monthly sampling, reflect important changes whose timing could be significant to the ecosystem. The data files will be made available on the time series homepage for downloading and as a graphical display. Key events will be highlighted and discussed as part of the graphical display.
2. Determine the basic statistical properties of the moored data and how variances in temperature, salinity, and dynamic height are distributed over depth and seasonally. Are there distinct vertical "modes" of variability that change with season? These results will also be summarized in a file containing textual, tabulated, and graphical information and will be accessible via the time series homepage.
3. We want to improve upon the understanding achieved this past year with respect to long-term freshwater forcing variations in the Gulf of Alaska. One approach to doing this is to compare simple atmospheric pressure patterns or indices with long term precipitation and/or stream flow measurements from around the gulf. Pressure patterns over the Northern Hemisphere have been reconstructed back to 1900. However, there is only one virtually continuous streamflow record for the northern Gulf of Alaska since ~1920 and continuous precipitation records date to 1930. Thus quantifying decadal scale variability is hampered by the lack of precipitation and discharge records. If proxies for these variables can be established then a surrogate discharge time series for the gulf can be reconstructed for the past 100 years. I anticipate that pressure patterns favoring northward atmospheric transport into the Gulf of Alaska might be highly correlated with regional runoff and precipitation. If such an index results then it would serve as a proxy for discharge variability dating to the early 1900s. Note that we are not trying to duplicate other indices (such as the PDO) which characterize hemispheric scales but rather to construct a more local (e.g., Gulf of Alaska) index that would be a better predictor of regional streamflow variations. These results will be made accessible on the homepage.

The first two objectives rely on continued sampling at GAK1. The last objective represents an exploratory study precipitated by the GAK1 data set and the results from Year 2 of this study reported by Weingartner (2000) and presented at the EVOS workshop and the AGU-ASLO Ocean Sciences meeting in 2000.

B. Methods

Funds are requested to monitor Gulf of Alaska temperature and salinity through FY 01, at which time a restructuring of the program described here will probably occur. By this time, the APEX and SEA programs will be completed and preliminary results from the U.S. GLOBEC-sponsored Gulf of Alaska monitoring component will be available (U.S. GLOBEC, 1996). Accomplishments from these programs (and from the work proposed herein) will catalyze a reconsideration of the monitoring effort. In addition, researchers working at the Alaska SeaLife Center will probably have monitoring interests to be considered as well.

We propose to collect data monthly with the Institute of Marine Science's 25-foot *Little Dipper* using a Seabird SBE-25 internally-recording CTD deployed from the vessel's winch. The sensors on this CTD are calibrated annually by the manufacturer. Field checks on the conductivity sensor are made from bottle salinities collected during each cast and analyzed on the salinometer at the Seward Marine Center. This procedure allows detection of CTD drift between calibrations by the manufacturer. The historical salinity data have an accuracy of ~0.01 or better using this instrument and these procedures. Temperatures are accurate to within 0.005°C.

The monthly sampling will be complemented by hourly measurements from six temperature/conductivity recorders (Seabird MicroCats; SBE model 37-SM) incorporated in a taut-wire, subsurface mooring at GAK1. The mooring can be deployed and recovered by the *Little Dipper* during the CTD cruises. The instruments will make hourly measurements at nominal depths of 30, 50, 100, 150, 200, and 250 meters. This distribution covers the near-surface (30 m), the upper ocean (30–100 m), mid-depth (150–200 m) and bottom (200–250 m) of the water column. (Although observations at the surface would be useful, obtaining these would entail a mooring with substantially higher hardware and fabrication costs and the need for a larger vessel for servicing.) While results from the first year indicate that mooring motion is unimportant, this is monitored with a pressure on the MicroCat at 30-m depth. Our prior experience with these and similar instruments (SeaCats) indicate that temperature and salinity drifts are generally <0.02°C and <0.03 psu/year, respectively.

The analyses of the data sets are straightforward.

Objective 1 is largely concerned with temporal aliasing issues associated with monthly sampling. Among the important processes that might be aliased are the summer onshelf influx of dense bottom water, changes in upper ocean stratification throughout the year as a consequence of winds and runoff, and the response of the thermohaline structure of the water column to synoptic scale forcing by the wind.

Objective 2 will be achieved by examining the empirical orthogonal functions (EOFs) of the temperature and salinity time series. The EOFs decompose the system variance into a set of linearly independent functions, with each describing a unique spatial and temporal structure. For the mooring data the system variance would be that computed from the salinity (or temperature) time series at all depths. Six EOF modes will result from the analysis because six depths are sampled. The modes are ordered according to the proportion of the total system variance that each comprise. Thus the first mode accounts for the greatest fraction of system variance and the sixth mode accounts for the smallest proportion. Often, only a few modes are required to describe the system variance, and the significance of a given mode will be assessed following Overland and Preisendorfer (1982). The spatial structure of a mode describes the distribution of amplitude with depth, while its temporal structure describes how the mode varies through time. The EOFs are useful in consolidating large and complicated data sets into smaller correlated subsets that facilitate physical interpretation. They might also contribute to future monitoring design by suggesting times and/or depths that are either over- or under-sampled. In the latter case, the EOFs could identify potential temporal or spatial aliasing problems.

For objective 3 I will use~40 years of monthly atmospheric precipitable water and atmospheric pressure indices obtained from the NCEP/NCAR reanalyzed meteorological fields interpolated

onto a 2.5° grid between 65°-35°N and 160°-120°W. (The website containing these data is http://www.cdc.noaa.gov./cdc/data.nmc.reanalysis.html#surface). The purpose is to construct statistical relationships between atmospheric pressure indices and precipitable water and stream discharge. Data for the latter are obtainable from the USGS website: http://2o-nwisw.cr.usgs.gov/nwis-w/AK/. We will also use Royer's Gulf of Alaska discharge time series in this analysis.

SCHEDULE

A. Measurable Project Tasks for FY 00 (October 1, 2000 – March 30, 2002)

October 15:	Monthly CTD surveys scheduled at mid-month; update homepage as CTD data are processed and edited; prepare wind fields and acquire meteorological fields.
November–December:	Deploy mooring (the mooring will be deployed as soon as instruments can be delivered from the manufacturer) during this month's CTD sampling.
September:	Recover mooring, send MicroCats for post-calibrations, begin data processing.
March:	A final report will be prepared by the end of March.

B. Project Milestones and Endpoints

The data collected as part of this project will be available to a broad community of users. We anticipate that some will want "immediate" access to it. This desire often conflicts with the goal (and required time) of producing data of the highest possible quality. In the past, the final CTD data have generally been placed online 1–2 months after collection. The final edited temperature and salinity data from the mooring should be ready three months after instrument recovery. The delays arise because of post-calibration requirements (performed by the manufacturer) and final editing of the data sets (performed at the Institute of Marine Science). We intend to make much of the data, along with preliminary results, available for rapid dissemination. From a practical point of view this approach is prudent because for many users the differences between the raw and the final edited product are insignificant. We will attach appropriate warnings concerning data quality to both preliminary and final data products. Thus, we anticipate making most of the data available on the homepage one month after recovery of the mooring. However, data will not be released if there are severe concerns regarding its quality unless and until such concerns are resolved. In addition to these general considerations, we anticipate the following project milestones:

1. The first objective is to examine rates of change of water mass properties (temperature and salinity) and the phasing of these changes at different depths. This work is largely descriptive and will begin immediately after instrument recovery. Graphical data displays will be made available within 1–2 months of recovery. These will include textural information indicating features of interest. Displays will be updated periodically as new findings emerge. Eventually these results will be merged with those of the third objective.

2. The second objective pertains to basic statistical results and provides the modal description of system variance. The results will be made available in both preliminary and final fashion. These calculations are straightforward and the results and preliminary interpretations would be made

available within two months of mooring recovery. When the final data product is ready, we will update the GAK1 CTD homepage describing these statistics and their relevance to historical GAK1 data.

3. The third objective requires considerably more effort and will be completed by the end of the project.

If the mooring is recovered in September 2000, all objectives will be reached by early April 2001. If the mooring is recovered as scheduled in December 2000, all objectives will be reached by early June 2001.

C. Completion Date

This project will be completed in FY 01.

PUBLICATIONS AND REPORTS

No manuscripts will be submitted in FY 00. Data and results will be provided via internet as indicated above. If a pressure index – discharge relationship for the Gulf of Alaska (Objective 3) can be established these results would provide the basis for a paper examining long-term discharge (the past 100 years) variability in the Gulf of Alaska.

PROFESSIONAL CONFERENCES

Portions of the research will be presented at the international meeting, The Eastern Pacific Ocean Conference to be held in September 2000 in Sidney, British Columbia. The PI has been invited to chair a session on observations of biological and physical interactions in the eastern Pacific Ocean.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

We have discussed aspects of the GAK1 historical data with several investigators supported by the Trustee Council. Many have expressed interest in these data and know how to access it. Other scientists are aware of these data through papers and meetings, (e.g., the American Geophysical Union which serves primarily the U.S. oceanographic community and the North Pacific Marine Science Organization [PICES] composed of marine scientists from around the Pacific Rim). Though we have discussed in previous sections how we would make these data available, we welcome advice from the Trustee Council on additional ways to share these data with other investigators and/or the public.

Several UAF scientists are co-investigators on a GLOBEC proposal whose results would complement this proposal. The UAF investigators (Coyle, Paul, Haldorson, Whitledge, Weingartner) along with Royer (Old Dominion University) have funding from the NSF NOAA GLOBEC program to examine the Gulf of Alaska shelf ecosystem for the period October 1997–December 2000. This work includes six R/V *Alpha Helix* cruises spaced throughout the year to

examine the cross-shelf hydrography (including nutrients) and the distribution of phytoplankton, primary production, zooplankton and fish (mainly juvenile salmon and forage fish) in relation to the physical environment. These investigators have submitted a proposal to NSF-NOAA to continue the GLOBEC monitoring work in the Gulf of Alaska for the 2001 – 2004 period. Our new proposal seeks support for seven cruises/year to sample the Gulf of Alaska shelf including GAK 1. We emphasize that there is a possibility for considerable cost-sharing through GLOBEC of the monthly sampling at GAK 1. *If our GLOBEC proposal is renewed, then the GLOBEC cruises will sample GAK 1 seven times each year and reduce the number of cruises required on the Little Dipper. The enclosed budget, which seeks support for 12 Little Dipper cruises/year could then be reduced.*

We see these programs as highly complementary in several ways. First, the cross-shelf hydrography will provide a basis for comparison with variations observed at GAK1. Second, a sufficient number of cross-shelf dynamic height *gradients* (proportional to the ocean transport) would be available (68 including the historical data and those under the new GLOBEC proposal) to examine the correlation between this gradient and dynamic height at GAK1. This result will help determine if dynamic height at a single station can provide an index of transport in the Alaska Coastal Current. Third, a comprehensive nutrient data set will be made available for establishing the type of correlations alluded to in the introduction. If significant correlations are obtained at several depths in the water column, then the GAK1 data would be a proxy indicator of historical variations in nutrient concentrations (for some depths).

The GLOBEC proposal makes connections with other investigators. For example, we have offered berth space on the *Alpha Helix* during our GLOBEC cruises to Robert Day of Alaska Biological Research, Inc., Fairbanks, for his sea bird and marine mammal studies. (Dr. Day is submitting a proposal to the Trustee Council for this project.) Thomas Kline of the Prince William Sound Science Center participated in four GLOBEC cruise and plans to participate in this year's cruises also.

The effort described in this proposal takes a modest but important step toward achieving the goal of long-term, comprehensive ecosystem monitoring. There are compelling scientific and logistical reasons for believing that GAK1 will be a long-term site and that the sampling will eventually expand to include other disciplines. Resurrection Bay and the adjacent ocean are paradigmatic for much of the Gulf of Alaska shelf, and this area is easily accessible by marine scientists at Seward. Although our understanding of chemical cycling and biological processes on this shelf is limited at the moment, programs such as SEA, APEX, and GLOBEC will provide substantial new information for these disciplines. Results from these programs and those anticipated from the work proposed herein will contribute to the design of a comprehensive long-term monitoring strategy. Additional impetus for expanding the monitoring activities at GAK1 will occur as programs at the Alaska SeaLife Center evolve.

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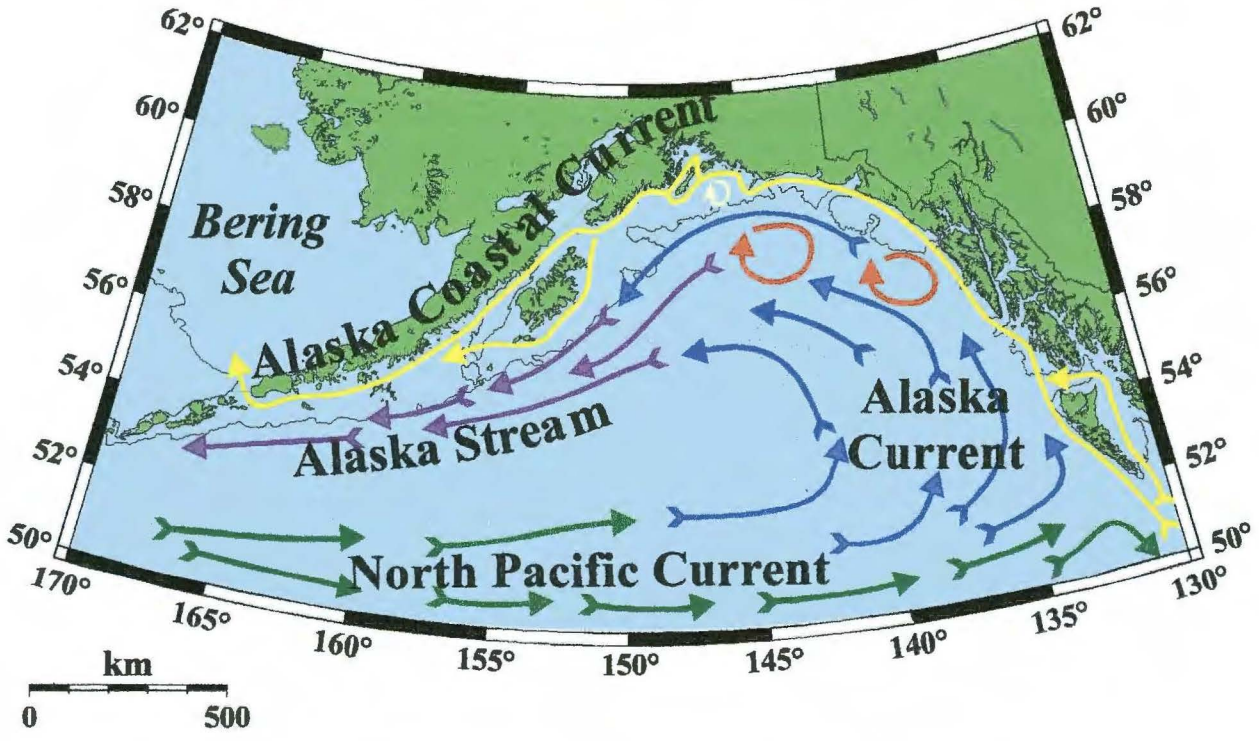

Figure 1. Schematic of the circulation of the Northeast Pacific and Gulf of Alaska.

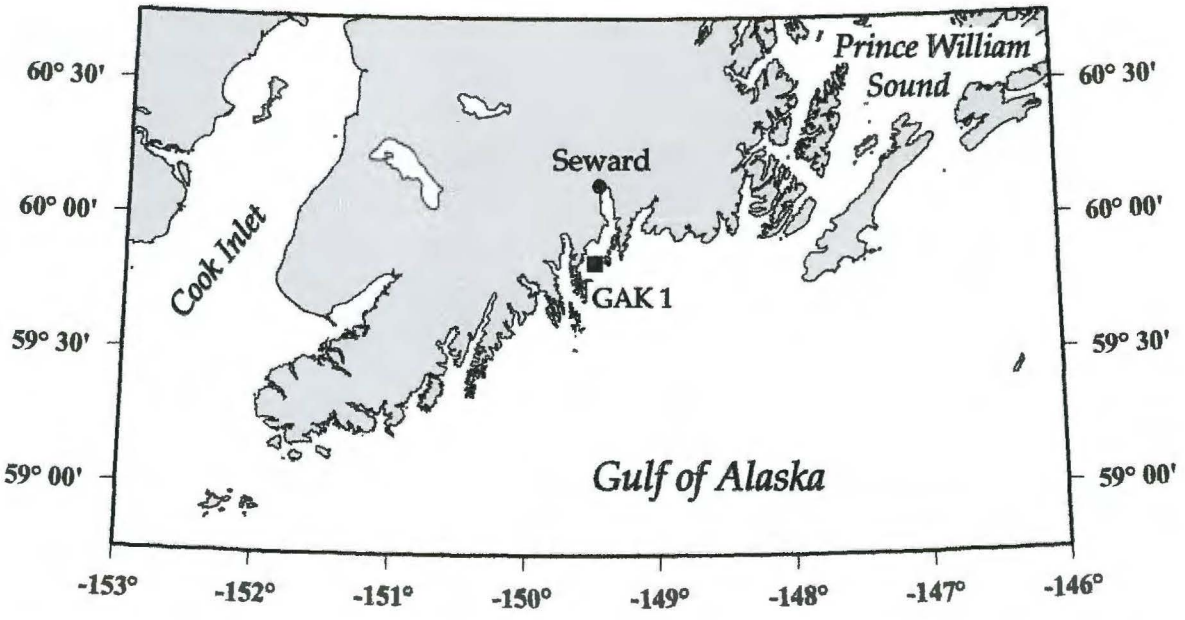

Figure 2. Map showing location of hydrographic station GAK1 in relation to Prince William Sound, Cook Inlet and Seward.

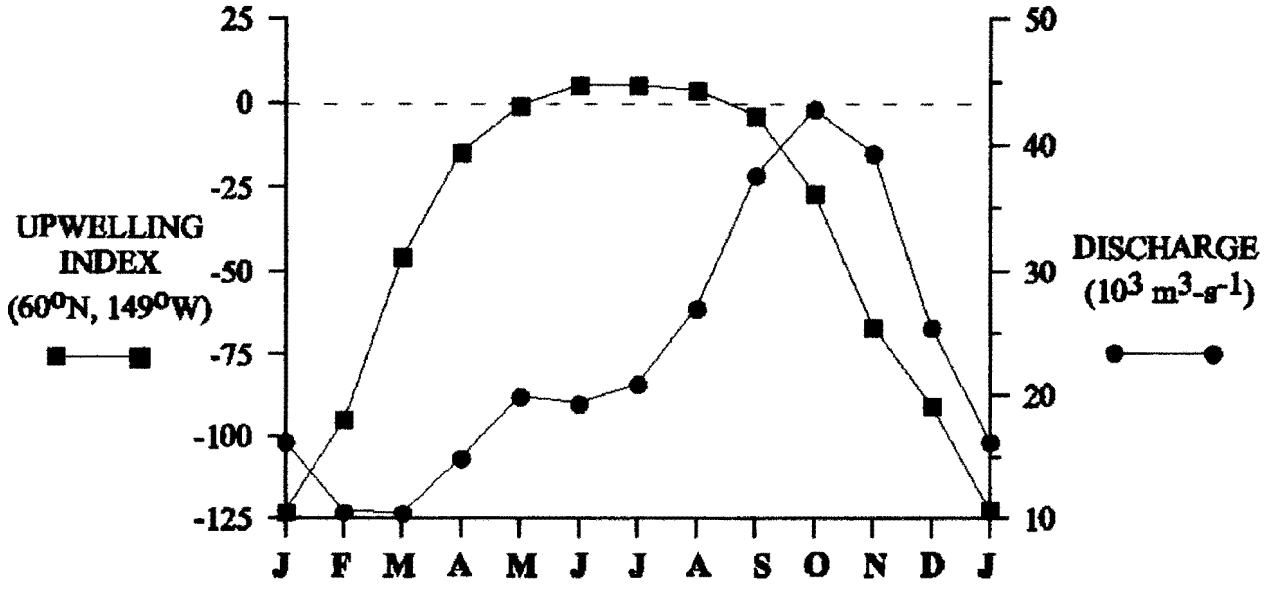

Figure 3. Mean monthly values of the upwelling index (from 1946–1995) and the estimated freshwater discharge (from 1930–1992) into the Gulf of Alaska using the hydrology model of Royer (1982).

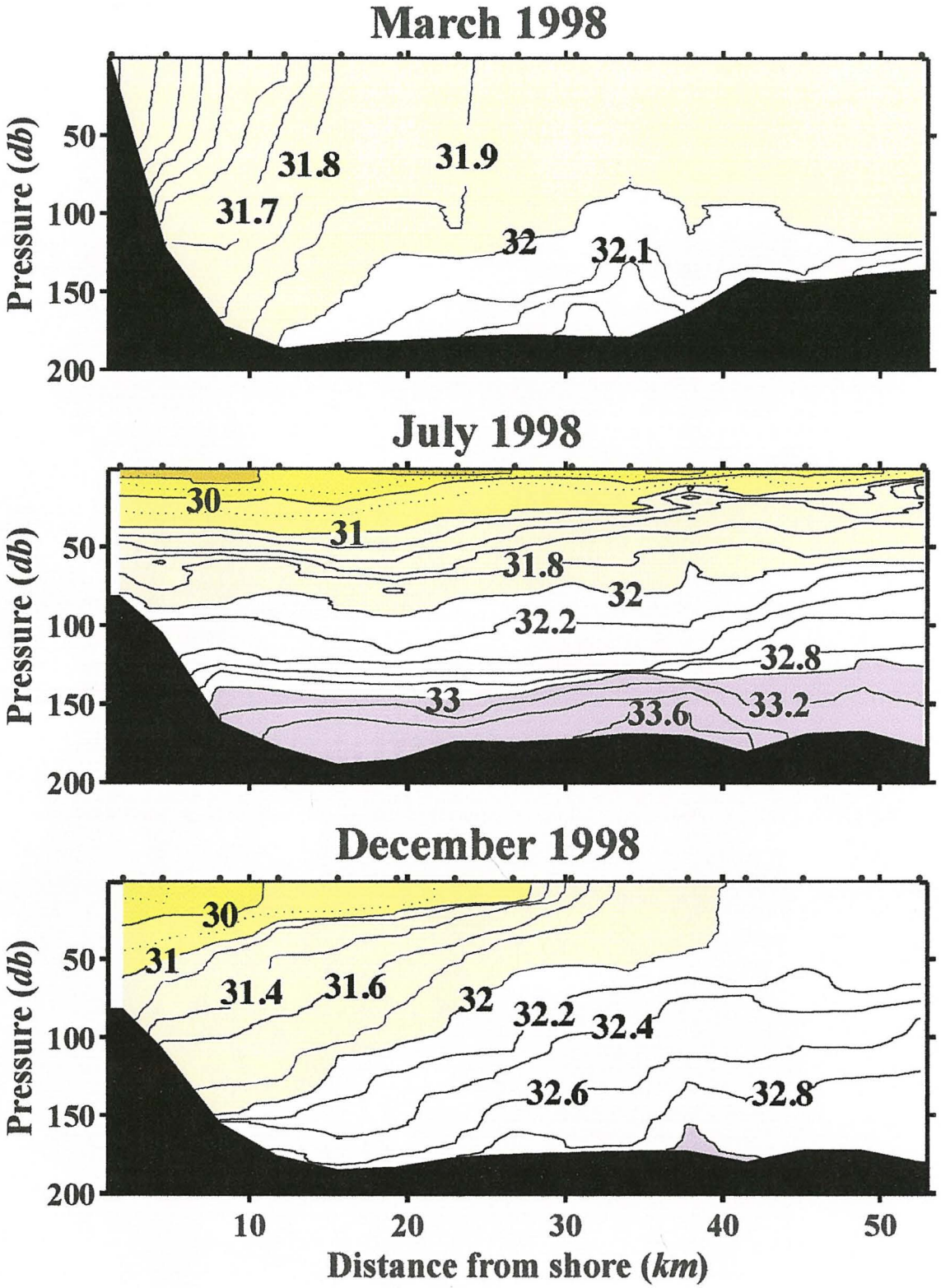

Figure 4. Contours of salinity as a function of depth and position in the Gulf of Alaska on a cross-shelf transect near GAK1. The upper panel is from April 1983 and the lower panel is from September 1993.

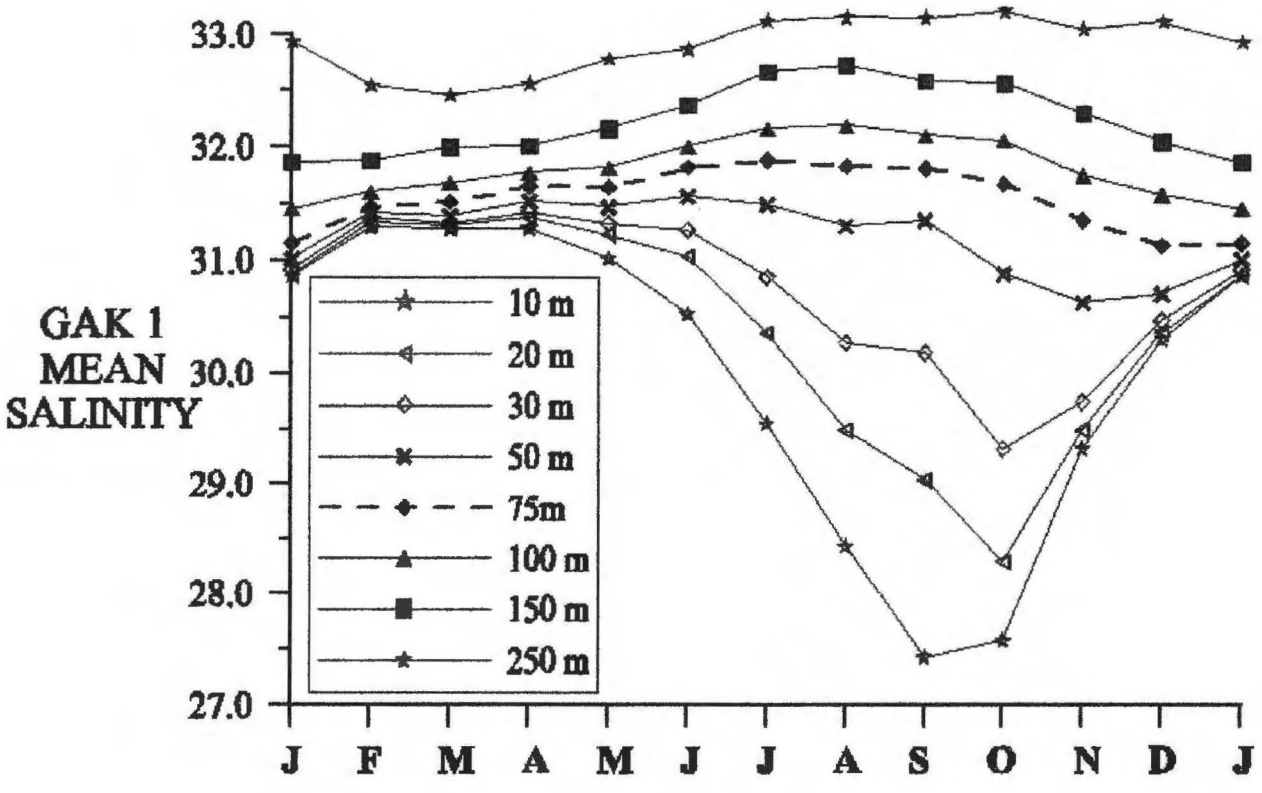

Figure 5. Mean monthly salinity at GAK1 as a function of depth. The means are computed from data collected between 1970 and 1996.

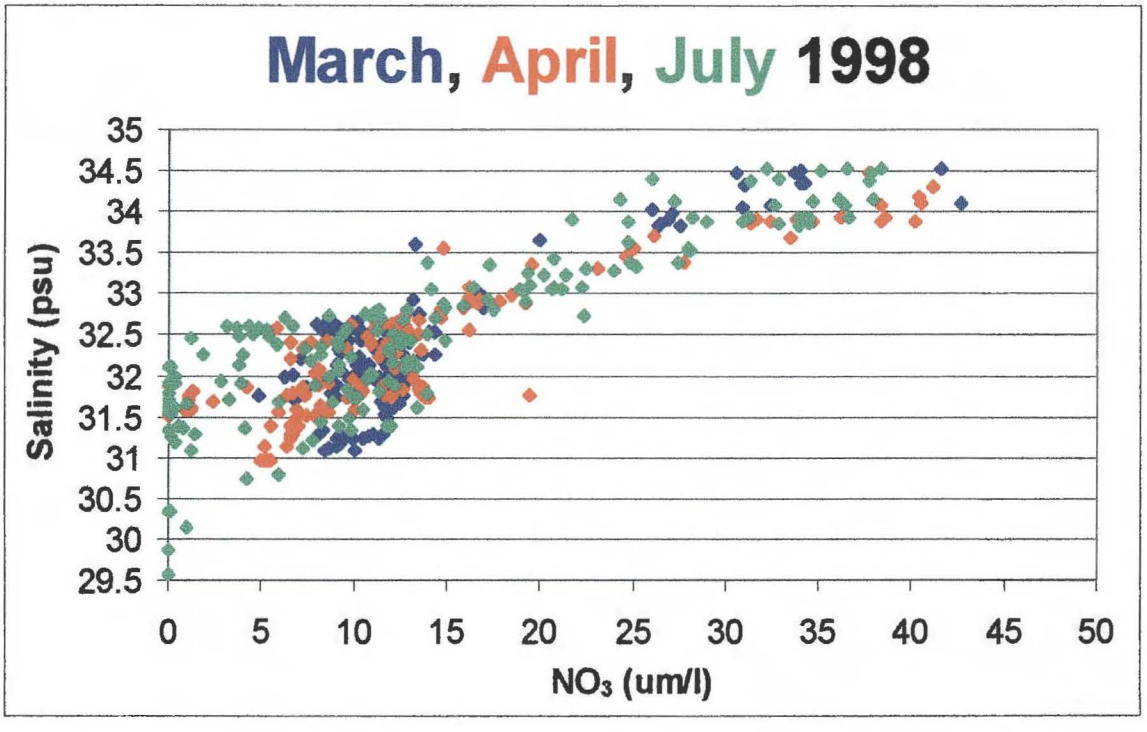

Figure 6. NO_3–salinity scatter plot from the shelf and slope of the northwest Gulf of Alaska (from Ruehs et al., 1999).

PRINCIPAL INVESTIGATOR

Thomas J. Weingartner

EDUCATION

Ph.D. Physical Oceanography, 1990, North Carolina State University
M.S. Physical Oceanography, 1980, University of Alaska
B.S. Biology, 1974, Cornell University

MEMBERSHIPS

American Geophysical Union; American Meteorological Society

PUBLIC SERVICE

Member, Science Steering Committee, NSF - Arctic System Science-Ocean Atmosphere Ice Interaction (OAII) component
Member, Science Steering Committee, NSF - ARCSS-OAII Shelf-Basin Initiative
Member, Science Steering Committee, NSF - ARCSS-Human Dimensions of the Arctic component
Member, UNOLS - Fleet Improvement Committee

PROFESSIONAL EXPERIENCE

Assistant Professor; Institute of Marine Science, School of Fisheries and Ocean Sciences, U. of Alaska Fairbanks, Alaska; 11/93 - present
Research Associate; Institute of Marine Science, School of Fisheries and Ocean Sciences, U. of Alaska Fairbanks, Alaska; 9/91 - 10/93
Postdoctoral Student; Institute of Marine Science, School of Fisheries and Ocean Sciences, U. of Alaska Fairbanks, Alaska; 7/88 - 8/91
Graduate Research Assistant; Department of Marine, Earth and Atmospheric Sciences, North Carolina State U.; Raleigh, North Carolina; and Department of Marine Science, U. of South Florida; St. Petersburg, Florida; 8/84 - 10/88

PROFESSIONAL INTERESTS

Physical oceanography of the Arctic and North Pacific Ocean and the adjacent shelves, biophysical linkages in oceanography; public education.

PUBLICATIONS

Weingartner, T. J., S. Danielson, Y. Sasaki, V. Pavlov, and M. Kulakov. The Siberian Coastal Current: a wind and buoyancy-forced arctic coastal current. *J. Geophys. Res.*, **104**: 29697 – 29713, 1999.

Münchow, A., T. J. Weingartner, and L. Cooper. On the subinertial summer surface circulation of the East Siberian Sea. *J. Phys. Oceanogr.*, 29: 2167 – 2182, 1999.

Weingartner, T. J., D. J. Cavalieri, K. Aagaard, and Y. Sasaki. 1998. Circulation, dense water formation and outflow on the northeast Chukchi Sea shelf. *J. Geophys. Res.* 103:7647-7662.

Gawarkiewicz, G., T. Weingartner, and D. Chapman. 1998. Sea Ice Processes and Water Mass Modification and Transport over Arctic Shelves. pp. 171-190 *in* K. H. Brink and A.

R. Robinson, (eds.), The Sea: Ideas and Observations on Progress in the Study of the Seas, Vol. 10.

Weingartner, T. J. 1997. A review of the Physical Oceanography of the Northeastern Chukchi Sea. Pp. 40-59, *in* J. Reynolds (ed.), Fish ecology in Arctic North America. American Fisheries Society Symposium 19, Bethesda, MD.

Cota, G. F., L. R. Pomeroy, W. G. Harrison, E. P. Jones, F. Peters, W. M. Sheldon, Jr., and T. J. Weingartner. Nutrients, photosynthesis and microbial heterotrophy in the southeastern Chukchi Sea: Arctic summer nutrient depletion and heterotrophy. *Mar. Ecol. Prog. Ser.* 135: 247-258.

Roach, A. T., K. Aagaard, C. H. Pease, S. A. Salo, T. Weingartner, V. Pavlov, and M. Kulakov. 1995. Direct measurements of transport and water properties through Bering Strait. *J. Geophys. Res.*, 100:18443-18458.

Falkner, K. K., R. W. Macdonald, E. C. Carmack, and T. Weingartner. 1994. The potential of Barium as a tracer of arctic water masses. *J. Geophys. Res., Nansen Centennial Volume.*

Liu, A. K., C. Y. Peng, and T. J. Weingartner. 1994. Ocean-ice interaction in the marginal ice zone using synthetic aperture radar imagery. *J. Geophys. Res.*, 99:22391-22400

Niebauer, H. J., Royer, T. C., and T. J. Weingartner. 1994. Circulation of Prince William Sound, Alaska. *J. Geophys. Res.*, 99:14113-14126

Coyle, K. O., G. L. Hunt, M. B. Decker, and T. Weingartner. 1992. The role of tidal currents in concentrating euphausiids taken by seabirds foraging over a shoal near St. George Island, Bering Sea. *Mar. Ecol. Progr. Ser.* 83:1-14.

Musgrave, D. L., T. J. Weingartner, and T. C. Royer. 1992. Circulation and hydrography in the northwest Gulf of Alaska. Deep-Sea Res. 39:1499-1519.

Weingartner, T. J. and R. H. Weisberg. 1991. A description of the annual cycle in sea surface temperature and upper ocean heat in the equatorial Atlantic. *J. Phys. Oceanogr.* 21:83-96.

Weingartner, T. J. and R. H. Weisberg. 1991. On the annual cycle of equatorial upwelling in the central Atlantic Ocean. *J. Phys. Oceanogr.* 21:68-82.

Royer, T. C., J. Vermisch, T. J. Weingartner, H. J. Niebauer, and R. D. Muench. 1990. Ocean circulation influence on the *Exxon Valdez* oil spill. *The Oceanography Society* 3:3-10.

Weisberg, R. H. and T. J. Weingartner. 1988. Instability waves in the equatorial Atlantic Ocean. *J. Phys. Oceanogr.* 18: 1641-1657.

Weisberg, R. H. and T. J. Weingartner. 1986. On the baroclinic response of the zonal pressure gradient in the equatorial Atlantic Ocean. *J. Geophys. Res.* 91:11717-11725.

Manuscripts in preparation:

Weingartner, T. J., K. Aagaard, D. J. Cavalieri, and Y. Sasaki. Winter baroclinic processes on the northeast Chukchi Sea shelf.

Weingartner, T. J., K. Aagaard, and Y. Sasaki. Circulation in Barrow Canyon and implications on shelf-basin exchange.

OTHER KEY PERSONNEL

Mr. David Leech is the Seward based mooring and marine technician responsible for the design and deployment of the mooring. He will also conduct the monthly CTD sampling from the *Little Dipper*. Mr. Mark Vallarino is the computer programmer who will assist in data processing, analyses, and maintain the web page. Both are employees of the Institute of Marine Science.

LITERATURE CITED

Albers, W. D. and P. J. Anderson. 1985. Diet of pacific cod, *Gadus macrocephalus*, and predation on the northern pink shrimp, *Pandalus borealis*, in Pavlof Bay, Alaska, *U.S. Fish. Bull.* 83:601–610.

Anderson, P. J., J. F. Piatt, J. E. Blackburn, W. R. Bechtol, T. Gotthardt. 1999. Long-term changes in Gulf of Alaska marine forage species 1953-1998, p. 137 abstract only, Legacy of an Oil Spill- 10 Years after *Exxon Valdez*, Anchorage, AK, March 23-26.

Blau, S. F. 1986. Recent declines of red king crab (*Paralithodes camstchatica*) populations and reproductive conditions around the Kodiak Archipelago, Alaska. *Can. Spec. Publ., Fish. Aquat. Sci.* 92:360–369.

Calkins, D. G. 1986. Marine mammals. Pp. 527–558 *in*: D. W. Hood and S. T. Zimmerman (eds.), *The Gulf of Alaska, Physical Environment and Biological Resources.* MMS/NOAA, Alaska Office, Anchorage, OCS Study MMS 86–0095.

Cayan, D. R. and D. H. Peterson. 1989. The influence of North Pacific atmospheric circulation on streamflow in the west. *Geophys. Monogr.*, Am. Geophys. Union, 55:375–397.

Chapman, D. C. and S. J. Lentz. 1994. Trapping of a coastal density front by the bottom boundary layer, *J. Phys. Oceanogr.*, *24*, 1464-1479.

DeGange, A. R. and G. A. Sanger. 1986. Marine birds. Pp. 479-526 *In* D. W. Hood and S. T. Zimmerman (eds.), *The Gulf of Alaska, Physical Environment and Biological Resources.* MMS/NOAA, Alaska Office, Anchorage, OCS Study MMS 86–0095.

Duffy, D. C. 1999. And an oil spill ran through it: lessons from the APEX study of the effects of the *Exxon Valdez* Spill on Alaskan Seabirds and Fish, p. 143 abstract only, Legacy of an Oil Spill- 10 Years after *Exxon Valdez*, Anchorage, AK, March 23-26.

Francis, R. C. and S. R. Hare. 1994. Decadal-scale regime shifts in the large marine ecosystems of the North-East Pacific: A case for historical science. *Fish. Oceanogr.* 3:279–291.

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

Hollowed, A. B., C. W. Wilson, E. Brown, and B. A. Megrey. 1994. Walleye pollock, *in*: Stock Assessment and Fishery Evaluation Report for the 1995 Gulf of Alaska Groundfish Fishery, North Pacific Fishery Management Council.

Incze, L. S. and T. Ainaire. 1994. Distribution and abundance of copepod nauplii and other small (40–300 mm) zooplankton during spring in Shelikof Strait, Alaska. *Fish. Bull.* 92:67–78.

Johnson, W. R., T. C. Royer, and J. L. Luick. 1988. On the seasonal variability of the Alaska Coastal Current. *J. Geophys. Res.* 93:12423–12437.

Kettle, A. B., D. G. Roseneau, G. V. Byrd. 1999. Progression of Common Murre nesting dates at East Amatuli Island, Alaska, during 1993 to 1998. p. 3 abstract only, Legacy of an Oil Spill- 10 Years after *Exxon Valdez*. Anchorage, AK, March 23-26.

Livingstone, D. and T. C. Royer. 1980. Observed surface winds at Middleton Island, Gulf of Alaska, and their influence on ocean circulation. *J. Phys. Oceanog.* 10:753–764.

Mantua, N.J., S. R. Hare, Y. Zhang, J. M. Wallace, and R.C. Francis, 1997. A Pacific interdecadal climate oscillation with impacts on salmon production, *Bull. Am. Met. Soc.*, 78: 1069-1079.

Merrick, R. L., T. R. Loughlin, and D. G. Calkins. 1987. Decline in the abundance of the northern sea lion, *Eumetopia jubatus*, in Alaska, 1956–86. *U.S. Fish. Bull.* 85:351–365.

Muench, R. D., J. D. Schumacher, and C. A Pearson. 1981. Circulation in Lower Cook Inlet, Alaska, NOAA Tech. Memo., ERL/PMEL–22, 147 pp.

Napp, J. M., L. S. Incze, P. B. Ortner, D. L. W. Siefert, and L. Britt. 1996, The plankton of Shelikof Strait, Alaska: standing stock, production, mesoscale variability and their relevance to larval fish survival. *Fish. Oceanog.* 5 (suppl. 1):19–38.

Niebauer, H. J., T. C. Royer, and T. J. Weingartner. 1994. Circulation of Prince William Sound, Alaska. *J. Geophys. Res.* 99:14113–14126.

Norcross, B. L., E. D. Brown, R. J. Foy, A. J. Paul, K. D. E. Stokesbury, S. J. Thornton, S. M. Gay III, T. C. Kline, Jr., V. Patrick, S. L. Vaughan, D. M. Mason, C. N. K. Mooers, and J. Wang. 1999. Life History of herring in Prince William Sound, Alaska, p. 40 abstract only, Legacy of an Oil Spill- 10 Years after *Exxon Valdez*, Anchorage, AK, March 23-26.

OCSEAP Staff; Marine fisheries: Resources and environments. 1986. Pp. 417-459 *in*: D.W. Hood and S.T. Zimmerman (eds.), *The Gulf of Alaska, Physical Environment and Biological Resources*. MMS/NOAA, Alaska Office, Anchorage, OCS Study MMS 86–0095.

Overland, J.E., S. Salo, and J.M. Adams, 1999. Salinity signature of the Pacific Decadal Oscillation, *Geophys. Res. Lett., 26*, 1337-1340.

Overland, J. E. and R. W. Preisendorfer. 1982. A significance test for principal components applied to a cyclone climatology. *Mon. Weather Rev.* 110:1–4.

Parker, K. S., T. C. Royer, and R. B. Deriso. 1995. High-latitude climate forcing and tidal mixing by 18.6-year lunar nodal cycle and low-frequency recruitment trends in Pacific halibut (*Hippoglossus stenolepis*). Pp. 449-459 *in* R.J. Beamish (ed.), *Climate Change and Northern Fish Populations*, *Can. Spec. Publ., Fish. Aquat. Sci.* #121.

Piatt, J. F. and D. B. Irons. 1999. Mesoscale interactions between seabirds and forage fish in the northern Gulf of Alaska, p. 139 abstract only, Legacy of an Oil Spill- 10 Years after *Exxon Valdez*, Anchorage, AK, March 23-26.

Preisendorfer, R. W. 1988. *Principal Component Analysis in Meteorology and Oceanography. Developments in Atmospheric Science Ser.*, Vol. 17. C. D. Mobley (ed.). Elsevier, New York, 425 pp.

Purcell, J. E., L. Haldorson, E. D. Brown, K. O. Coyle, T. C. Shirley, R. T. Cooney, M. V. Sturdevant, T. Gotthardt, L. A. Joyal, D.C. Duffy. 1999. The food web supporting forage fish populations in Prince William Sound, Alaska, p. 138 abstract only, Legacy of an Oil Spill- 10 Years after *Exxon Valdez*, Anchorage, AK, March 23-26.

Reeburgh, W. S. and G. W. Kipphut. 1986. Chemical distributions and signals in the Gulf of Alaska, its coastal margins and estuaries, Pp. 77-91 *in* D.W. Hood and S.T. Zimmerman (eds.), *The Gulf of Alaska, Physical Environment and Biological Resources*. MMS/NOAA, Alaska Office, Anchorage, OCS Study MMS 86–0095.

Reed, R.K. and J.D. Schumacher. Physical Oceanography, 1986. IN: *The Gulf of Alaska, Physical Environment and Biological Resources*. Pp. 57-76 *in* D.W. Hood and S.T. Zimmerman (eds.), MMS/NOAA, Alaska Office, Anchorage, OCS Study MMS 86–0095.

Royer, T. C. 1996. Interdecadal hydrographic variability in the Gulf of Alaska, 1970–1995, *EOS Trans. AGU*. 77:F368.

Royer, T. C. 1993. High-latitude oceanic variability associated with the 18.6 year nodal tide. *J. Geophys. Res.* 98:4639–4644.

Royer, T. C. 1982. Coastal freshwater discharge in the Northeast Pacific. *J. Geophys. Res.* 87:2017–2021.

Royer, T. C. 1981. Baroclinic transport in the Gulf of Alaska, Part II. Freshwater driven coastal current. *J. Mar. Res.* 39:251–266.

Royer. T. C. 1979. On the effect of precipitation and runoff on coastal circulation in the Gulf of Alaska. *J. Phys. Oceanogr.* 9:553–563.

Royer, T. C. 1975. Seasonal variations of waters in the northern Gulf of Alaska, *Deep-Sea Res.* 22:403–416.

Royer, T. C., J. Vermisch, T. J. Weingartner, H. J. Niebauer, and R. D. Muench. 1990. Ocean circulation influence on the *Exxon Valdez* oil spill. *Oceanogr. Soc.* 3: 3–10.

Ruehs, A. M., T. E. Whitledge, D. A. Stockwell, T. Weingartner, S. L. Danielson, K. O. Coyle. 1999. Major nutrient distributions in relation to the physical structure of the Gulf of Alaska shelf, *Eos, Transaction, AGU*, **80**: OS262.

Stabeno, P. J., R. K. Reed, and J. D. Schumacher. 1995. The Alaska Coastal Current: continuity of transport and forcing. *J. Geophys. Res.* 100:2477–2485.

Thompson, G. G. and H. H. Zenger. 1994. Pacific cod, *in*: *Stock Assessment and Fishery Evaluation Report for the 1995 Gulf of Alaska Groundfish Fishery*, North Pacific Fishery Management Council.

Trenberth, K. E. and J. W. Hurrell 1994. Decadal atmosphere–ocean variations in the Pacific, *Clim. Dyn.* 9:303–319.

U.S. GLOBEC Northeast Pacific Implementation Plan. 1996. U.S. GLOBEC, Scientific Steering Committee Coordinating Office, Dept. Integrative Biol., University of California, Berkeley, Report Number 17, 60 pp.

Vance, T. C., J. D. Schumacher, P. J. Stabeno, C. T. Baier, T. Wyllie-Echeverria, C. Tynan, R. D. Brodeur, J. M. Napp, K. O. Coyle, M. B. Decker, G. L. Hunt, Jr., D. Stockwell, T. E. Whitledge,

M. Jump, and S. Zeeman. 1998. Aquamarine waters recorded for the first time in eastern Bering Sea, *EOS, Trans. Am. Geophys. Union*, 79(10):121.

Weingartner, T., T. C. Royer, and S. Danielson. 2000. Toward long-term oceanographic monitoring of the Gulf of Alaska ecosystem, *Exxon Valdez* Oil Spill Annual Workshop, January 2000, Anchorage, Alaska.

Weingartner, T. 2000. Toward long-term oceanographic monitoring of the Gulf of Alaska ecosystem, *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 98340), Alaska Department of Fish and Game, Habitat and Restoration Division, Anchorage, Alaska.

Weingartner, T. 1999. Toward Long-Term Oceanographic Monitoring of the Gulf of Alaska Ecosystem, *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 98340) Alaska Department of Fish and Game, Habitat and Restoration Division, Anchorage, Alaska.

Wilson, J. G. and J. E. Overland. 1986. Meteorology, IN: *The Gulf of Alaska, Physical Environment and Biological Resources.* D. W. Hood and S. T. Zimmerman (eds.), MMS/NOAA, Alaska Office, Anchorage, OCS Study MMS 86-0095, 31-54.

Willette, T. M., R. T. Cooney, V. Patrick, G. L. Thomas, T. C. Kline, Jr., K. Hyer, G. Carpenter, M. Clapsadl. 1999. Ecological processes influencing mortality of juvenile pink salmon in Prince William Sound, Alaska, p. 39 abstract only, Legacy of an Oil Spill- 10 Years after *Exxon Valdez*, Anchorage, AK, March 23-26.

Williams, W. J. and T. J. Weingartner. 1999. The response of buoyancy driven coastal currents to downwelling favorable wind-stress *Eos, Transaction, AGU*, **80**: OS262.

Wilson, J. G. and J. E. Overland. 1986. Meteorology, Pp. 31-54 *in* D. W. Hood and S. T. Zimmerman (eds.), *The Gulf of Alaska, Physical Environment and Biological Resources.* MMS/NOAA, Alaska Office, Anchorage, OCS Study MMS 86-0095.

Wong A.P.S., N. L. Bindoff, and J. A Church. 1999. Large-scale freshening of the intermediate waters in the Pacific and Indian Oceans, *Nature, 400*, 440-443.

Xiong, Q. and T. C. Royer. 1984. Coastal temperature and salinity observations in the northern Gulf of Alaska, 1970–1982, *J. Geophys. Res.* 89:8061–8068.

Yankovsky, A. E. and D. C. Chapman. 1997. A simple theory for the fate of buoyant coastal discharges, *J. Phys. Oceanogr.*, *27*, 1386-1401.

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001						
Personnel		$0.0						
Travel		$0.0						
Contractual		$67.3						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$67.3			Estimated FY 2002	Estimated FY 2003		
General Administration		$4.7						
Project Total		$72.0						
Full-time Equivalents (FTE)		0.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY01

Prepared:

Project Number: 01340
Project Title: Toward Long-Term Oceanographic Monitoring of the Gulf of Alaska Ecosystem
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 1999	Proposed FY 2000						
Personnel		$39.4						
Travel		$0.7						
Contractual		$11.7						
Commodities		$2.1						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$53.9			Estimated FY 2001	Estimated FY 2002		
Indirect		$13.4						
Project Total		$67.3						
Full-time Equivalents (FTE)		0.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

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

The budget costs include time for the PI and the technicians to complete the data analysis and report writing after the instruments are recovered from the ocean. Calibrations would be completed by December 2001 and the final report completed by the end of March 2002. The PI will spend 1.5 months on the project between December 2001 and March 2002, and Vallarino will devote a month of his time to this project between December 2001 and March 2002.

FY01

Prepared:

Project Number: 01340
Project Title: Toward Long-Term Oceanographic Monitoring of the Gulf of Alaska Ecosystem
Name: Thomas J. Weingartner

FORM 4A
Non-Trustee
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 2000
Weingartner, T.	Principal Investigator/Assistant Prof.		2.0	6.8		14.2
Vallarino, M.	Computer programmer		2.0	5.7		10.9
Leech, D.	Mooring and marine technician		2.3	5.7	0.3	14.3
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	6.3	18.2	0.3	
					Personnel Total	$39.4

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 2000
R/T Fairbanks to Anchorage		300.0	1	3	120.0	0.7
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$0.7

FY01

Prepared:

Project Number: 01340
Project Title: Toward Long-Term Oceanographic Monitoring of the Gulf of Alaska Ecosystem
Name: Thomas J. Weingartner

FORM 4B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed
Description	FY 2000
Little Dipper (4 full days @ $500/day and 2 half days @ $250/hday)*	2.5
CTD calibration (SBE-25)	0.6
Microcat calibration (6 @ $600 ea.)	3.6
Shipping (R/T Seward to Seattle, CTD and MicroCats)	1.0
*This estimate would be revised downward if the GLOBEC monitoring proposal submitted by Weingartner and colleagues is funded. In that case, GLOBEC will fund seven cruises/year on the RV *Alpha Helix*. Little Dipper cost would be for 3 full days and 2 half-days to total $2,000.	
Contractual Total	$7.7

Commodities Costs:	Proposed
Description	FY 2000
Batteries, O-rings, tools	1.0
Shackles, sling links, thimbles	0.5
Standard seawater (6 @ $30/vial)	0.2
Mooring anchor and lashing chain	0.4
Commodities Total	$2.1

FY01

Prepared:

Project Number: 01340
Project Title: Toward Long-Term Oceanographic Monitoring of the Gulf of Alaska Ecosystem
Name: Thomas J. Weingartner

FORM 4B
Contractual & Commodities DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

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	

FY01

Project Number: 01340
Project Title: Toward Long-Term Oceanographic Monitoring of the Gulf of Alaska Ecosystem
Name: Thomas J. Weingartner

FORM 4B
Equipment
DETAIL

Prepared:

Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet

Project Number:	01341
Restoration Category:	Research
Proposer:	University of Alaska Fairbanks
Lead Trustee Agency:	ADFG
Cooperating Agencies:	none
Alaska SeaLife Center:	yes
Duration:	4th year, 4-year project
Cost FY 01:	$90,114
Cost FY 02:	Closeout costs
Geographic Area:	Kenai Peninsula, Seward
Injured Resource/Service:	Harbor seal

ABSTRACT

This program is the last year data analysis year of a long-term study underway at the Alaska SeaLife Center quantifying the impact of feeding differing fish diets on the health and body condition of harbor seals. Even though health status biomarkers for marine mammals in Prince William Sound were established during EVOS supported field trials, this ASLC program is the critical test of how each marker varies in a seal depending on diet and season. The project has also been designed to establish whether specific diets are nutritionally adequate to maintain seal condition by monitoring health parameters and assimilation efficiency during feeding trials. While this project focuses on the issue of harbor seal health, the approach is potentially applicable to any of the injured top predators.

INTRODUCTION

An underlying component of the ecosystem-based research approach supported by the Trustee Council has been the hypothesis that food limitation could be inhibiting the recovery of injured species in Prince William Sound (PWS). Inherent in this concept is the assumption that food stressed animals can be distinguished by population-wide surveys of critical health parameters. Following this approach, an extensive sampling effort by multiple projects established a series of biomarkers used to profile the health and body condition of wild populations of marine mammals inside PWS. Population health status and body condition indices were developed and tested for a range of birds, sea otters and seals. On the basis of this wide-ranging effort, reference range values for these health parameters have been established and are being used to compare whole groups of animals across time and space (1–7). This approach is critical to understanding how these markers work on a population health level.

Establishing such a series of population-wide health indicators is necessary, but not sufficient, to link their biological activity to known health problems or food limitation. This is because the variability of each indicator over time or under different feeding conditions in any one individual cannot be tested in the field. In the sea otter and seal studies conducted under Trustee Council funding, each individual animal can only be captured once. Recaptures of individuals are extremely rare and opportunistic. Thus, we can establish the range of reference values for any particular indicator across a whole group of animals, but we do not know how this indicator varies within any given animal under changing conditions of health or feeding status.

The Trustee Council has supported the population-monitoring component of health biomarkers for marine mammals in Prince William Sound. At the Alaska SeaLife Center (ASLC) in Seward, we have been testing those biomarkers under controlled conditions, in the same animals over time and under changing experimental conditions. Of particular interest is the effect of specific diets on harbor seal physiology. This addresses the question of food limitation more completely, including the suggestion that certain prey may not be nutritionally adequate. Work on birds using the basic elements of this concept is also underway (5).

The Alaska SeaLife Center took possession of eight harbor seals in April 1998. Feeding trials for these seals began in September 1998 and will conclude in September 2000. The health and condition of the animals has been closely monitored (weight, morphometrics and biweekly blood samples). The database includes values for standard veterinary chemical and hematological values, morphological measurements including mass, length and girths, and ultrasound measurements to assess blubber depth. In addition, samples have been collected to determine levels of various biomarkers used in field studies, including haptoglobin, nitric oxide, metalothionien and levels of copper and zinc. The SeaLife Center also successfully rehabilitated three harbor seal pups in 1998 and four in 1999. Each of the pups was monitored carefully, including weekly morphometric measurements and blood samples to compare with the known healthy adult animals in the feeding trials.

Feeding protocols for the experiments were established in conjunction with the ASLC veterinarian and pinniped husbandry staff. Six of the eight seals were placed on experimental diets (herring or pollock) that were switched every four months for two years. The four-month periods correspond to three seasons – winter/molt, spring and summer. At the end of two years, each seal will have been on each diet during each season. Two additional seals have been placed on a mixed (50%

pollock, 50% herring) diet for the duration of the study. Monitoring of health and condition has continued, including biweekly measurement of weight, morphometrics and blood sampling. Assimilation efficiency and body condition experiments were conducted for each seal at the end of each trial. The seals are currently (April 2000) towards the end of the fifth feeding trial.

The animals being used in this study are also involved in two other EVOS-funded Restoration Projects. Using the same feeding protocols, Project 00371 is conducting experiments on stable isotope analysis with diet changes and Project 00441-BAA is conducting experiments on fat metabolism.

Fish being used as prey in this study are being analyzed for % water, % lipid, % nitrogen and energy density. These analyses are conducted regularly throughout the study to monitor different fish batches and any nutritional changes which may occur during food storage. Mean lipid content (± S.D; wet mass basis) for herring used in this study was 16.8 ± 2.2 % (n = 90), compared to pollock which was 4.9 ± 1.1% (n = 24). Mean energy density (± S.D.; wet mass basis) for herring was 9.5 ± 0.9 kJ/g (n = 40) compared to 5.1 ± 0.5 kJ/g (n = 25) for pollock. There has been no loss of lipid or energy density in frozen storage.

Data from the first year of trials indicate that body morphology, percent body fat and mass fluctuations are under a seasonal influence. Several blood enzymes and metabolites appear to change in response to diet, some with a potential seasonal component. These include, but may not be limited to, alanine aminotransferase, aspartate aminotransferase, gamma-glutamyl transpeptidase and creatinine. Most hematological variables were fairly constant, although hematocrit and hemoglobin values appear to be influenced by season, with no apparent effect of diet. Assimilation experiments are still in the early phase of analysis, although preliminary results suggest increased retention time on a herring diet. Statistically, the effects of diet, season and age cannot be separated until the end of the six trials, so while these data are interesting, they are preliminary and, by no means conclusive.

Seven harbor seal pups were successfully rehabilitated at the ASLC during 1998 and 1999. Two additional pups were more seriously injured and did not recover. While the number of individuals studied at this point is low, preliminary results show extreme perturbation in blood parameters of severely compromised individuals as well as long-term changes in blood parameters and morphometrics as individuals recover and develop. A number of potential factors could contribute to the variability, including development, captivity, early weaning and disease or injury. Pups had low cholesterol values when formula-fed, and decreases in gamma-glutamyl transpeptidase, triglyceride and hematocrit levels during their recovery. Percent granulocyte levels were good inidcators of exposure to infection. Increased sample collection and further analyses will enable more specific conclusions about the differences between healthy and unhealthy animals.

All ASLC work on this project will conclude in mid September 2000. The funding request for this proposal is for final laboratory analyses and statistical development. No further experimental work is expected during this year. The final report (April 2002) will be included in the next budget year.

NEED FOR THE PROJECT

A. Statement of Problem

The Restoration Program has established a strong field component that has tested a series of health and body condition biomarkers for many of the top-level predators in the Sound (1,2,4-6), including harbor seals (3,7). Many of these indices are related to metabolic alterations that might occur in animals that are food limited, or stressed. These include markers for fat, protein and carbohydrate metabolism (fatty acid patterns, blood urea nitrogen, ketone bodies, glucose), water balance (plasma and whole blood water), blubber quality in harbor seals (energetic density, lipid distribution, histology) and total body fat. Other markers have addressed more health or contaminant related issues such as indicators of oil contamination (P450, PAH), whole body inflammatory response (haptoglobin, interleukin), organic residue contamination (PCB) and clinical indicators of disease state (clinical chemistry panels, blood hemograms).

While this significant field-based effort is critical, these markers must be tested in the laboratory where animals can be fed different diets and put onto controlled caloric intakes. These markers must also be tested in the same animals over long time periods so that individual variance and seasonal differences can be monitored and experimental conditions altered. For example, we suspect that molting condition in harbor seals impacts haptoglobin levels, an indicator of inflammatory response, but until we follow the same animal through a whole season, we will not be able to test this theory. Finally, these markers must also be tested in animals known to be sick or injured (rehabilitation, stranded) to quantify how they vary with disease or poor health.

Recent results from a number of EVOS Restoration Projects (presented at Legacy of an Oil Spill: 10 Years after the *Exxon Valdez* Oil Spill) have demonstrated the critical nature of food composition to the growth and success of several injured species. The physiological response of seals to diets markedly different in lipid and energy content (assimilation efficiency, metabolizable energy, passage rate) are being assessed in captive seals fed the same controlled diets being used for monitoring health parameters.

B. Rationale/Link to Restoration

If we theorize that various health and body condition markers react in the field to ecosystem-wide changes in food availability or animal health, then we should be able to quantify those mechanisms in the laboratory under controlled conditions. The SeaLife Center has research animals that are healthy and have been put onto differing diets of specific prey. In addition, it has physiologically compromised animals that are brought in for rehabilitation. Both groups allow us to examine how these health markers respond to food and health status. Experiments following the same conceptual protocol have been carried out in Europe on harbor seals fed diets of fish that differed in contaminant loads (8). In those studies, it was found that seals fed contaminated fish showed measurable decreases in immune function. In this proposal, we have not been feeding contaminated fish, but rather fish of differing energy densities (pollock and herring) and monitoring unhealthy animals that are at the Center for rehabilitation. These "rehab" animals represent seals whose ability to survive in the wild has been compromised and they present a unique view into the biology of compromised animals that are under-represented in our field studies in the Sound (7).

An additional rationale concerns the "junk food" hypothesis. One of the most popular hypotheses concerning the cause for the decline of marine mammals and birds in Alaskan waters was first

voiced at a Sea Grant sponsored workshop in 1991 on whether or not food limitation could account for the observed population patterns (9). At that workshop, the "junk food" hypothesis was proposed. This thesis stated that Alaskan waters had a sufficient biomass of pollock to support the harbor seals and Steller sea lions populations, ***but*** pollock was nutritionally poor compared to other less common species, such as herring and capelin. Because the marine ecosystem of Alaska experienced a "regime shift" in the late 1970s that moved the system from a groundfish/herring based food web to a pollock dominated food web, the high-energy food that pinnipeds used to eat simply disappeared. Thus, the hypothesis proposes that seals and sea lions may be starving in a sea full of pollock. The experiments we have been conducting at the ASLC allow us to critically test this hypothesis.

C. Location

The experiments for this work are being conducted at the Alaska SeaLife Center in Seward. Additional studies on harbor seals (Restoration Project 00371 and 00941) have been using the same feeding regime for their experiments. Thus, there is considerable collaboration between the projects and significant sharing of resources and personnel. Similar experiments are underway with Steller sea lions through funding provided by the National Fish and Wildlife Foundation and NOAA.

For this budget period, all projects at the ASLC will have been concluded and final analyses and statistical tests will be conducted at the University in Fairbanks.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The field work on harbor seals has involved integral collaboration with Native communities throughout the Gulf region in conjunction with the BIOSAMPLING program (Project /244) and we anticipate Native collaboration to continue. The Alaska SeaLife Center, the EVOS Trustee Council, the Alaska Native Science Commission and the Alaska Native Harbor Seal Commission are all currently working on joint scientific collaboration. Harbor seals are important food items for many Native communities, and results of these and previously funded studies will continue to be shared at the Alaska Native Harbor Seal Commission meetings.

An important mission of the Alaska SeaLife Center is to educate the public about unique Alaskan habitats and the importance of stewardship. It spotlights the role that research plays in understanding and contributing to the stewardship of that environment. Research done at the SeaLife Center is highly visible both to local communities as well as thousands of visitors each year. Recently, the National Park Service has declared the ASLC a NPS Public Learning Center with a focus on the population declines of harbor seals in Alaska which will further this collaboration. Researchers involved in our study volunteer time at the SeaLife Center to present information directly to the public, including school groups, and to provide updated information about the project to the Education Department.

PROJECT DESIGN

A. Objectives

This project quantifies the nutritional value of key Alaskan fish species for harbor seals and follows seal condition indices over time in both healthy and rehabilitation animals. There are four major objectives:

1. Feed controlled diets of pollock and herring to harbor seals.

2. Quantify body condition, health, and blood chemistry biomarker changes in the seals during the feeding trials and in rehabilitation seals during recovery.

3. Assess the assimilation efficiency (AE) of the different fish diets for harbor seals.

4. Quantify seasonal, metabolic state and clinical health impacts on biomarkers and health indices.

B. Methods

Feeding schedules and timing patterns of controlled diets have been developed in conjunction with the ASLC veterinarian and pinniped staff. There are other EVOS funded research projects that are taking advantage of controlled diet protocols and the design allows for the accommodation of these needs. In particular, EVOS Restoration Projects /371 and /441-BAA utilize the same feeding schedules to conduct their work on lipid metabolism and stable isotope biochemistry.

The eight harbor seals are currently in residence at the ASLC. Each animal is examined every two weeks for all measurements and all are trained to submit voluntarily to morphometric measurements and to voluntarily move onto scales to obtain mass values at least once a week. Several seals have been successfully trained to allow voluntary blood sampling. The eight animals are evenly split male/female, while four are mature animals and four are young.

Food maintenance trials

A detailed matrix of the feeding schedule is shown below. The procedure utilizes a cross-over repeated measures approach that allows statistical comparisons within any one group of seals between diet and season. Statistical software (SYSTAT) is used to analyze the cross-over method.

CROSS-OVER REPEATED MEASURES ANOVA
FEEDING TRIALS FOR HARBOR SEALS

PERIOD	HERRING	POLLOCK	CONDITION
Sept–Dec 1998	Seals A,B,C	Seals D,E,F	Molting
Jan–Apr 1999	D,E,F	A,B,C	Spring
May–Aug 1999	A,B,C	D,E,F	Breeding
Sept–Dec 1999	D,E,F	A,B,C	Molting
Jan–Apr 2000	A,B,C	D,E,F	Spring
May–Aug 2000	D,E,F	A,B,C	Breeding

Two seals (G, H) are in a separate feeding group. They are being fed a mixed diet of herring and pollock throughout the study. These animals will undergo the same procedures as the animals on single prey diets.

This feeding matrix allows each group of seals to experience a different diet at similar physiologically relevant times of the year. Group A,B,C, for example, was fed a herring diet during molting season in year one and a pollock diet in year two.

A problem with cross-over ANOVA designs is that residual or carry-over effects from previous treatments can complicate the analyses. We correct for this with extremely long test periods and phased cross-overs. That is, since each feeding trial lasts for four months, several weeks of diet switching are allowed. This provides the additional advantage of allowing us to study the biochemical impact of the phased switch.

In any captive situation, the behavior of the pinniped may influence feeding patterns, especially if the diet changes in palatability (10-11). Fortunately for this study, both fish species are part of the natural diet of harbor seals. In addition, feeding trials extend for four months and trainers work with the animals continually on feeding behavior. Animals are switched gradually from one diet to another over several weeks as the percentage of herring or pollock is adjusted. Under controlled feeding conditions, the feeding frequency during any given day impacts issues such as satiation and over-feeding. The trainers and husbandry personnel make sure that the animals are fed at the same time each day with a regular and adequate food intake.

An additional consideration is the number of animals per feeding trial. As shown above, we stagger animals through these long-term feeding schedules; however, three to six animals per trial are commonly used (12) and considered adequate for determinations of digestive efficiency.

Long-term alterations in the basic metabolic needs of the animals will occur as a result of annual cycles (e.g., molting). The metabolic demand of phocids varies throughout the year (13–14). We assume that the absolute number of maintenance calories per unit time changes seasonally. To offset these problems we have implemented the staggered feeding regime shown above. We separate the seals into two groups of three, one feeding on a different food item than the other. Each group feeds on a given food item for at least four months, then alternates with another group at the end of each four-month trial. These feeding trials last for two years, exposing each animal to various seasonal or yearly cycles with each prey species. This schedule provides standard deviations in assimilation efficiency, digestive efficiency and metabolizable energy while minimizing potential errors associated with temporal fluctuations (season or year) or metabolism (e.g., molting) and confounding errors associated with each prey item during a particular feeding trial. Although staggered feeding methods have been utilized in captive bird studies (15) few data exist on long-term assimilation studies for captive marine mammals.

The final issue is the application of laboratory data to the field environment. We are not modeling the metabolic demands of harbor seals in the wild. The stresses and food requirements of wild populations are very different from captive animals. Instead, we are investigating the metabolic response to differing diets and the effect of these diets on blood chemistry, blubber physiology and body condition of these animals. That is, we do not seek to model how many calories an animal may consume per month and apply that to field estimates of mass of fish consumed at sea. We

quantify how blood chemistry biomarkers change when an animal is fed several different kinds of fish and compare those chemical changes to observed patterns already collected from wild populations. This study is designed to investigate whether fish diets and seasonal alterations in food demand impact these chemical levels.

The food provided to the seals comes from frozen stocks of Alaska herring and pollock held by the ASLC husbandry collection. The fish are analyzed for body composition and inventoried by batch number so that any variation in food composition can be monitored. Analysis includes %water (freeze drying), %lipid (soxhlet extraction), %nitrogen (Kjeldahl extraction) and energy density (bomb calorimetry). Fish that are stored long-term are re-analyzed every one to three months.

Body condition, health and blood chemistry alterations

BODY CONDITION

Seals are weighed at least at every biweekly handling. The trainers continue to reinforce voluntary behaviors, and the seals are often weighed several times a week. At biweekly handling times, measurements of length, girth and blubber depth (using portable ultrasound) are collected. Every four months whole body bio-impedance (BIA) is measured as a proxy for water content and calibrated with labeled water. In this technique, deuterated water (D_2O) is injected into the seal, allowed to equilibrate with the total body water and then blood samples are drawn to measure D_2O dilution. This is a routine procedure for body water determination and we have used it on both Steller sea lions and harbor seals. In order to facilitate the field/laboratory comparisons, these morphological indices are the same as those we developed for use on wild populations of pinnipeds. Models of the most sensitive indicators for the field animals exist for harbor seals (7).

BLOOD CHEMISTRY

To date, we have a database of blood indices from over 500 adult harbor seals and 150 harbor seal pups as well as 350 Weddell seals, 400 Steller sea lion pups, 60 Steller sea lion juveniles and over 80 Steller sea lion adults collected under field conditions. These indices include not only clinical veterinary panels of blood chemistry and hematology, but also additional indicators we have developed for specialized use on pinnipeds.

Blood samples have been collected every two weeks from each harbor seal throughout the duration of the study. The blood sample is taken from the extradural sinus directly into the appropriate vacuum collection tube. We routinely take blood into both EDTA (for hematology) and heparin tubes (for chemistry). The blood is analyzed on site for most of the metabolites and hematological parameters of interest. Because these animals are highly trained for research protocols, this frequency of handling has not induced any negative behaviors that could compromise the project. All eight seals have been handled by research teams for many years and have easily adapted to their research protocols.

One of the implications of the junk food hypothesis is that the impacted animals are nutritionally stressed. Therefore, we have developed a series of blood indicators that provides a profile of the fasting and starvation status of pinnipeds. These markers include *ketone bodies* (metabolites produced to support neural function in the face of decreasing food intake), *blood urea nitrogen* (marker for increased muscle tissue degradation during starvation), *differential fatty acid utilization* (selective utilization of fat from lipid stores in the blubber during fasting), *water balance* in the plasma (particularly sensitive as pups gain nutritional independence) and red cell

characteristics including *hemoglobin content cell* and *mean cell volume*. We have found these markers to be useful in determining whether or not pinnipeds are feeding, fasting, or entering starvation in the wild (16-19).

Nutritional assimilation

Estimating prey or nutritional requirements of a predator using an energy model necessitates that assimilation efficiency be quantified (20). Assimilation efficiency (AE), which is defined as the proportion of dry matter assimilated from a prey source, is influenced by food quality, meal size, feeding frequency and digestive passage rate (21–23). Recent studies have suggested that assimilation efficiency is low when food quality is low (15, 24). For example, harp seals (*Phoca groenlandica*) fed Atlantic herring or capelin had a higher AE, and consumed less food, than those fed invertebrates of lower energy density (24). However, conflicting results have been reported for harbor seals (13) and northern fur seals (10), while studies of California sea lions fed pollock did not show a significant decrease in AE with lower energy density food, such as pollock (25).

Once the seals have been established on a specific diet during each feeding trial, they participate in two feeding experiments to quantify assimilation efficiency and metabolizable energy (ME). Each seal is fed a diet of the specific prey item(s), keeping other variables such as meal size and feeding frequency constant. In the first experimental regime, feeding frequency is four times a day. In the second regime feeding frequency is once a day. The design and interpretation of feeding experiments takes into account the potential effects of seasonal variation in AE and ME and this is discussed above in the feeding trial design using staggered schedules.

For all animals, dietary prey and fecal samples are freeze-dried and analyzed for energy (kJ/g), nitrogen, total lipid, and ash. Bomb calorimetry is used for energy density, nitrogen (protein) concentration is determined using a carbon–nitrogen auto-analyzer, total lipid by Soxhlet extraction and ash by muffle furnace combustion.

To determine digestibility of food absorbed in the digestive tract of seals, inert markers such as chromic oxide and cobalt-EDTA are added to the diets and subsequently assayed in fecal samples. These inert markers, along with naturally occurring manganese (Mn^{2+}) levels, are used to determine assimilation efficiency and compared with the digestibility results of a total balance trial. These markers have been used in pinniped AE studies (25–26) where dry matter digestibility has been calculated. Chromium, cobalt and Mn^{2+} concentrations are assessed using atomic absorption spectrophotometry (26). The tissue samples are extracted in Seward and analyzed by staff in Fairbanks.

In order to determine the passage of digesta (mean retention time), feces are collected during the feeding experiments. Rate of passage of digesta is one of the important factors that determine the efficiency of utilization of food (27). It has been documented in birds that the retention time of food in the gut is a function of food quality (28). In pinnipeds, such as the harbor seal, data indicate both high caloric prey items with soft parts and low caloric prey species have the fastest transit times through the digestive tract (29). However, the assimilation efficiency of the prey items fed to these seals was not known. Miller (10) reported that the passage rate of digesta in sub-adult female northern fur seals was rapid, although the AE appeared to be consistently high for the different prey items. Mean retention time is calculated in order to examine its relationship with AE. If prey size and feeding frequency are equal in all trials, prey items with higher energy

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The Marine Mammal Protection Act permit and internal UAF and ASLC Institutional Animal Care and Use Committee permits required for this project are active.

SCHEDULE

A. Measurable Project Tasks for FY 01 (October 1, 2000 – September 30, 2001)

September-November:	Close down of all operations at ASLC. Sample and data transfer to Fairbanks.
November-February:	Final analyses of samples. EVOS annual meeting.
March-April:	Annual Report, prepare closeout DPD, meeting with collaborative projects.
April-September:	Final data analyses.

B. Project Milestones and Endpoints

FY 01: Wrap-up of feeding protocols, final data analysis

C. Completion Date

The experimental project will finish on September 30, 2001. Final report due April, 2002.

PUBLICATIONS AND REPORTS

The first annual report for this project, entitled Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet (7), has been accepted by the Trustee Council. This report presented baseline information about the seals before feeding trials were begun, as well as preliminary data on rehabilitated harbor seals. The second annual report has been submitted and contains results from the first series of feeding trials and more extensive analysis of data obtained from rehabilitated seals.

PROFESSIONAL CONFERENCES

Work on this project will be presented at the EVOS meeting in January 2001 and the Alaska Native Harbor Seal Commission meeting in March 2001. Presentations at other conferences are covered by travel grants through different sources.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

As noted above, there are several continuing projects on controlled diets in birds and mammals at the ASLC. These multiple experiments require close coordination from the associated principal investigators, the ASLC animal staff, veterinarian and staff, science officer and executive director.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This proposal is for the final analyses and sample testing for /341 with no changes in plan.

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Michael A. Castellini, Ph.D., specializes in metabolic chemistry problems associated with marine mammals. He is a tenured Professor of Marine Science at UAF and has worked in this field for over 25 years.

Publications by Dr. Castellini since 1990 relevant to the proposal include:

Castellini, M.A. and G.L. Kooyman. Length, girth, and mass relationships in Weddell seals (*Leptonychotes weddellii*). Marine Mammal Science. 6(1): 75–77. 1990.

Castellini, J.M., M.A. Castellini and M.B. Kretzmann. Circulatory water balance in suckling and fasting northern elephant seal pups. Journal of Comparative Physiology B. 160(5): 537–542. 1990.

Castellini, M.A. and D.P. Costa. Relationships between plasma ketones and fasting duration in neonatal elephant seals. American Journal of Physiology. 259: R1089–R1090. 1990.

Castellini, M.A., J.M. Castellini and V.L. Kirby. Blood glucose handling methods can compromise analytical results: Evidence from marine mammals. Journal of the American Veterinary Association. 201(1): 145–148. 1992.

Castellini, M.A., D.P. Costa and J.M. Castellini. Blood glucose distribution, brain size and diving in small odontocetes. Marine Mammal Science. 8(3): 294–298. 1992.

Castellini, M.A. and L.D. Rea. The biochemistry of natural fasting at its limits. Experientia. 48: 575–582. 1992.

Castellini, M. and D. Calkins. Mass estimates using body morphology in Steller sea lions. Marine Mammal Science. 9: 48–54. 1993.

Castellini, M.A., R.W. Davis, T.R. Loughlin and T.M. Williams. Blood chemistries and body condition of Steller sea lion pups at Marmot Island, Alaska. Marine Mammal Science. 2: 202–208. 1993.

Castellini, J.M., H.J. Meiselman and M.A. Castellini. Understanding and interpreting hematocrit measurements in pinnipeds. Marine Mammal Science. 12: 251–264. 1996.

Zenteno-Savin, T., M.A. Castellini, L.D. Rea and B.S. Fadely. Plasma haptoglobin levels in threatened Alaskan pinniped populations. Journal Wildlife Diseases. 33(1): 64–71. 1997.

Rea, L.D., R. Groscolas, E. Mioskowski and M. Castellini. Changes in the fatty acid composition of plasma lipids indicate nutritional status in developing Weddell seal pups. Polar Biology. 18:351–357. 1997.

Rea, L.D., M.A. Castellini and B.S. Fadely. Health status of young Alaska Steller sea lions (*Eumetopias jubatus*) as indicated by blood chemistry and body condition. Canadian Journal of Zoology. 120 A: 617-623. 1998.

Zenteno-Savin, T., M.A. Castellini. Plasma angiotensin II, arginine vasopressin and atrial natriuretic peptide in free ranging and captive seals and sea lions. Comparative Biochemistry and Physiology. 119C:1-6. 1998.

Burns, J.M., S.J. Trumble, M.A. Castellini and J.W. Testa. The diet of Weddell seals in McMurdo Sound, Antarctica, as determined from scat collections and stable isotope analysis. Polar Biology. 19:272-282. 1998.

OTHER KEY PERSONNEL

J. M. Castellini, M.Sc., is a UAF Research Associate and has worked on marine mammal biochemistry/physiology projects since 1986. She is currently the laboratory director and provides daily project monitoring. Her role includes blood chemistry analysis, proximate analysis of prey, quality control, computer analysis and publication preparation.

Steve Trumble received his M.S. degree in 1995 from California State University Fresno (Moss Landing Marine Laboratory) where he worked on the feeding pattern and lactation habits of harbor seals. He has completed work on the third year of a UAF Rasmuson Fisheries Research Fellowship for his Ph.D. thesis on feeding patterns and health issues for harbor seals in Alaska. This EVOS proposal deals with the laboratory component of his thesis and support from ADF&G covers the field component. He has completed four field seasons investigating health and development of harbor seal pups at Tugidak Island, Alaska. Rasmuson support will end on June 30, 2001 and support is requested for three months of support through September 2001.

Tami Mau is a Ph.D. student working on lipid chemistry patterns in marine mammals. Her component of this project involves analysis of blood lipid profiles. She is also responsible for collection and processing of samples.

LITERATURE CITED

1. EVOS Project 96102. Comprehensive killer whale investigations in Prince William Sound.

2. EVOS Project 96025. Mechanisms of impact and potential recovery of nearshore vertebrate predators.

3. EVOS Project 96064. Monitoring, habitat use and trophic interactions of harbor seals in Prince William Sound.

4. EVOS Project 96163G. Diet composition, reproductive energetics and productivity of seabirds damaged by the *Exxon Valdez* Oil Spill.

5. EVOS Project 96163N. Effects of diet quality on post-natal growth of seabirds: Captive feeding trials.

6. EVOS Project 96170. Isotope ratio studies of marine mammals in Prince William Sound.

7. Fadely, B.S., J.M. Castellini and M.A. Castellini. Recovery of harbor seals from EVOS: Condition and Health Status, *Exxon Valdez* Oil Spill Restoration Project Final Report (97001), Alaska Department of Fish and Game, Anchorage, AK.

8. Ross, P.S., R.L. de Swart, H.H. Timmerman, P.J.H. Reijnders, J.G. Vos, H. Van Loveren and A.D.M.E. Osterhaus. 1996. Suppression of natural killer cell activity in harbour seals fed Baltic Sea herring. Aqua. Tox. 34:71–84.

9. Alaska Sea Grant. 1993. Is it Food?: Addressing marine mammal and sea birds declines. Workshop Summary. Alaska Sea Grant Report 93–01.

10. Miller, L.K. 1978. Energetics of the northern fur seal in relation to climate and food resources of the Bering Sea. U.S. Marine Mammal Commission. No. MMC–75/08. Washington, D.C. 27pp.

11. Bigg, M.A. 1979. Studies on captive fur seals. Progress Report No. 3. Submitted to the Standing Scientific Comm., 22nd Annual Meeting, North Pacific Fur Seal Commission. 35pp.

12. Mothershead, C.L., R.L. Cowan, and A.P. Ammann. 1972. Variations in determinations of digestive capacity of the white-tailed deer. J.Wildl.Manag. 36:1052–1060.

13. Ashwell-Erickson, S. and R. Elsner. 1981. The energy cost of free existence for Bering Sea harbor and spotted seals. In: Hood, D.W. and J.A. Calder (eds.), The Bering Sea Shelf: Oceanography and Resources, Vol. 2., pp. 869–899. Univ. Wash. Press.

14. Bowen, W.D., D.J. Boness and O.T. Oftedal. 1987. Mass transfer from mother to pup and subsequent mass loss by the weaned pup in the hooded seal, *Cystophora cristata*. Can. J. Zool. 65:1–8.

15. Brekke, B. and G.W. Gabreilsen. 1994. Assimilation efficiency of adult kittiwakes and Brunnich's guillemots fed capelin and arctic cod. Polar Biol. 14:279–284.

16. Schneider, B.H., and Flatt, W.P. 1975. The evaluation of feeds through digestibility experiments. University of Georgia Press, Athens.

17. Castellini, M.A. and L.D. Rea. 1992. The biochemistry of natural fasting at its limits. Experentia. 48:575–582.

18. Rea, L.D. 1995. Prolonged fasting in pinnipeds. Ph.D. Thesis. University of Alaska Fairbanks. 135pp.

19. Rea, L.D., M.A. Castellini, B.S. Fadely, T.R. Loughlin. 1998. Health status of young Alaska Steller sea lion pups as indicated by blood chemistry and hematology. Comp. Biochem. Physiol. In Press.

20. Thompson, P.M., D.J. Tollit, H.M. Corpe, R.J. Reid and H.M. Ross. 1998. Changes in haematological parameters in relation to prey switching in a wild population of harbor seals.

Funct. Ecol. 11:743-750.

21. Lavigne, D.M., W. Barchard, S. Innes and N.A. Øritsland. 1982. Pinniped bioenergetics. FAO Fish. Ser. No.5, 4:191–235.

22. Robbins, C.T. 1983. Wildlife feeding and nutrition. Academic Press, New York.

23. Lawson, J.W., J.A. Hare, E. Noseworthy and J.K. Friel. 1999. Assimilation efficiency of captive ringed seals (*Phoca hispida*) fed different diets. Polar Biol. In Press.

24. Mårtensson, P E., E.S. Nordøy and A.S. Blix. 1994. Digestibillity of crustaceans and capelin in harp seals (*Phoca groenlandica*). Mar. Mam. Sci. 10(3):325–331.

25. Fadely, B.S., J.A. Zeligs and D.P. Costa. 1994. Assimilation efficiencies and maintenance requirements of California sea lions fed walleye pollock and herring. Unpublished final report, National Marine Mammal Laboratory, NMFS, Seattle, WA. 28pp.

26. Fadely, B.S., G.A.J. Worthy and D.P. Costa. 1990. Assimilation efficiency of northern fur seals determined using dietary manganese. J. Wildl. Manag. 54:246–251.

27. Kotb, A.R. and T.D. Luckey. 1972. Markers in nutrition. Nutrit. Abstr. Rev. 42:813–845.

28. Afik, D. And W.H. Karasov. 1995. The trade-offs between digestion rate and efficiency in warblers and their ecological implications. Ecology. 76(7):2247–2257.

29. Markussen, N.H. 1992. Transit time of digesta in captive harbor seals (*Phoca vitulina*). Can. J. Zool. 71:1071–1073.

2001 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$0.0						
Travel		$0.0						
Contractual		$84.2						
Commodities		$0.0						
Equipment		$0.0						
Subtotal		$84.2			Estimated	Estimated		
General Administration		$5.9						
Project Total		$90.1						
Full-time Equivalents (FTE)		1.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY01

Prepared:

Project Number: 01341
Project Title: Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001						
Personnel		$55.5						
Travel		$3.8						
Contractual		$6.1						
Commodities		$2.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$67.4			Estimated	Estimated		
Indirect		$16.8						
Project Total		$84.2						
Full-time Equivalents (FTE)		1.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

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

Student personnel costs include resident tuition of $3,006 per year.

FY01

Prepared:

Project Number: 01341
Project Title: Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet
Name: Michael A. Castellini

FORM 4A
Non-Trustee
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2000
	Michael Castellini	PI, Professor	2.5	7.9		19.7
	J. Maggie Castellini	Research Associate	3.4	4.7		16.0
	TBA	Ph.D. Student	12.0	1.7		19.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	17.9	14.3	0.0	
					Personnel Total	$55.5

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2000
	Fairbanks to Anchorage	250.0	2	5	120.0	1.7
	Fairbanks to Cordova	300.0	1	3	120.0	0.7
	Fairbanks to Seward	250.0	2	4	120.0	1.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$3.8

FY01

Prepared:

Project Number: 01341
Project Title: Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet
Name: Michael A. Castellini

FORM 4B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed
Description	FY 2000
Blood analysis (50 samples @ $45/assay)	2.3
Prey analysis (100 samples @ $8/assay)	0.8
Communications	1.0
Publications	2.0
Contractual Total	$6.1

Commodities Costs:	Proposed
Description	FY 2000
Samples collection	0.5
Lab expendables	1.5
Commodities Total	$2.0

FY01

Prepared:

Project Number: 01341
Project Title: Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet
Name: Michael A. Castellini

FORM 4B
Contractual & Commodities DETAIL

2001 EXXON VALDEZ TRU! COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

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		

FY01

Prepared:

Project Number: 01341
Project Title: Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet
Name: Michael A. Castellini

FORM 4B
Equipment
DETAIL

The *Exxon Valdez* Oil Spill: Guidance for Future Research Activities "Submitted Under the BAA #52ABNF900033"

Project Number:	BAA 01360
Restoration Category:	Ecosystem Synthesis
Proposer:	Chris Elfring, Polar Research Board, National Research Council
Lead Trustee Agency:	NOAA
Cooperating Agencies:	N/A
Alaska SeaLife Center:	No
Duration:	2nd year of three-year project
Cost FY 00:	$196,450
Cost FY 01:	$315,980
Cost FY 02	$84, 234
Geographic Area:	
Injured Resource/Service:	potentially all

ABSTRACT

The Exxon Valdez Oil Spill Trustee Council has established a trust to support long-term environmental research and monitoring for the northern Gulf of Alaska in perpetuity. The Trustee Council expects the research and monitoring to make it increasingly possible to detect and understand the origins and consequences of long-term biological change in the region, and to communicate this knowledge to all concerned. Funds from the trust are expected to be disbursed starting in late 2003. The National Research Council's Polar Research Board (PRB) and Board on Environmental Studies and Toxicology (BEST) propose to appoint a special committee to review the scope, content, and structure of the draft Science Program and, when available, the draft Research and Monitoring Plan. To provide context for reviewing the drafts, the committee will become familiar with the relevant body of scientific knowledge, including but not limited to that developed by activities sponsored by the Trustee Council in the past. Since the Research and Monitoring Plan will be under active development as the committee reviews the more Science Program, effective communications among concerned parties are essential to this project. The committee will prepare an interim report on the adequacy of the Science Program, which will then help the Trustee Council in development of the Research and Monitoring Plan. The committee will then prepare a final report analyzing whether the Research and Monitoring Plan is complete, scientifically sound, and meets the expectations of the Trustee Council. Both reports will contain conclusions and recommendations intended to give guidance on the nature and scope of future research and monitoring activities in the northern Gulf of Alaska. The committee's review will start in federal fiscal year 2000 (FY 00), continue in FY 01, and conclude in FY 02.

INTRODUCTION

The Polar Research Board (PRB) and Board on Environmental Science and Toxicology, units of the National Research Council (NRC), propose to review the scope, content, and structure of the draft Science Program and draft Research and Monitoring Plan the Exxon Valdez Oil Spill Trustee Council is preparing to guide long-term research and monitoring in the northern Gulf of Alaska. To provide context for reviewing the drafts, the committee will become familiar with the relevant body of scientific knowledge, including but not limited to information developed from activities sponsored by the Trustee Council in the past. The committee will prepare an interim report on the adequacy of the Science Program. The committee will then prepare a final report analyzing whether the Research and Monitoring Plan is complete, scientifically sound, and meets the expectations of the Trustee Council.

This study will be conducted by a special committee of volunteer experts, supported by a small staff and following standard NRC procedures regarding committee selection, committee operation, and report review. The committee will be composed of approximately 12 people selected to have appropriate expertise and experience for the task. The committee will meet six times over a period of 20 months to gather information, deliberate, and produce an interim report and a final report with guidance about the design and implementation of the research and monitoring program. This proposal seeks support for this activity in the amount of $315,980 for year two.

Because of the postponement of delivery of the original draft GEM plan for review, spending of FY 00 project funds for this project is below original year one projections. To date, funds have been spent on staff time to conduct the committee selection process and for the study director to attend the 2000 Restoration Workshop, and are projected to be used for tasks related to holding committee meetings in June and September. This is less activity than originally proposed and will require some shifting of resources from year one to year two.

NEED FOR THE PROJECT

A. Statement of the Problem

The Exxon Valdez Oil Spill Trustee Council is one-third of the way through a three-year process of developing, reviewing, and adopting a Science Program and a Research and Monitoring Plan. The Trustee Council requires independent peer review of the Science Program and the detailed Research and Monitoring Plan as part of its development and implementation process. The first implementation projects are to be funded by the Council no earlier than October of 2002. The Science Program and the Research and Monitoring Plan are expected to guide the Trustee Council's activities as it moves beyond the era of short-term oil spill damage assessment and restoration investigations. The Trustee Council's vision for the future is to implement long-term monitoring and related research that permit improved understanding of the origins and consequences of biological changes in the northern Gulf of Alaska. The vision includes effectively

communicating those understandings to all parties concerned with the management and use of birds, fish, shellfish, mammals, and other organisms.

A program rooted in the science of a large-scale ecological disaster may be uniquely suited to form the foundation for ecosystem-based management. Knowledge and experience gained during ten years of biological and physical studies on the aftermath of the Exxon Valdez oil spill taught the Trustee Council that a solid historical context is essential to guide decisions. The context provided by research and monitoring permit understanding of the origins and consequences of changes in valued natural resources and the ecosystem that supports those resources. The history of the oil spill and its science are part of the background necessary to understand the science program and the research and monitoring plan.

As background, in 1989 the T/V Exxon Valdez spilled 11 million gallons of crude oil into Prince William Sound in Alaska. In 1991, the U.S. District Court approved a civil settlement that required Exxon Corporation to pay the United States and the State of Alaska $900 million over 10 years to restore the resources injured by the spill and compensate for the reduced or lost services (human uses) the resources provide. Under the court-approved terms of the settlement, a Trustee Council of three federal and three state members was formed to administer the funds. The mission of the Council has been to return the environment to a "healthy, productive, world-renowned ecosystem" by restoring, replacing, enhancing, or acquiring the equivalent of natural resources injured by the spill and the services provided by those resources.

Funds from the Exxon Valdez Oil Spill Trustee Council (EVOS) have been disbursed for almost 10 years, at first for damage assessment activities (approximately 1989-1991) and then in relation to identified important "resource clusters," or communities/resources affected by the oil spill (1992 to present). These include: (1) pink salmon; (2) Pacific herring; (3) Prince William Sound ecosystem assessment (SEA); (4) sockeye salmon; (5) cutthroat trout, Dolly Varden trout, rockfish, and pollock; (6) marine mammals; (7) nearshore ecosystem communities (NVP); (8) seabird/forage fish and related resources (APEX); (9) archaeological resources; (10) subsistence resources; (11) reduction of marine pollution; (12) habitat improvement; and (13) ecosystem synthesis. Extensive research has been conducted in each of these areas over the decade, making this the most studied cold water marine oil spill in history.

During the course of its existence, the Trustee Council has pursued independent, non-government agency peer review of its projects, encouraged and funded publication in peer reviewed scientific journals, and fostered interdisciplinary collaboration essential to ecosystem oriented studies. Three ecosystem-based studies, the Sound Ecosystem Assessment (SEA), the Nearshore Vertebrate Predator projects, and the Avian Predator Ecosystem Experiments (APEX), have advanced understanding of food web relations among organisms at a range of trophic levels, the influences of atmospheric and oceanographic processes on productivity of key species, ecological energetics among key species, flow of carbon across trophic levels and among geographic regions, marine-terrestrial linkages, and many other topics.

Many other scientific studies conducted by entities not associated with the Trustee Council are relevant to the NRC committee's efforts. An important body of information is formed by the investigations known as Outer Continental Shelf Environmental Assessment Program (OCSEAP) conducted with the support of the federal Minerals Management Service. The pace of advances in fisheries oceanography, atmospheric sciences, and biological and physical oceanography of the Gulf of Alaska during the past 15 years also has been great. Advances in knowledge in the Bering Sea have been particularly intense over the past two decades, and much of this knowledge is relevant to the Gulf of Alaska due to physical and biological linkages between these regions.

As the Trustee Council plans a strategy for continued research and monitoring in perpetuity in the region, it must consider options for building on the now-large base of scientific knowledge made possible in part by Trustee Council studies. The final payment from the Exxon Corporation will arrive in 2002, after which activities will be funded solely out of the Restoration Reserve, which was created from portions of the Exxon Corporation payments saved over the previous 10 years. The trust will fund a scientific program and research and monitoring plan to guide future resource management activities, and independent peer review of scientific content is considered essential.

B. Rationale/Link to Restoration

An independent assessment of the proposed Science Program and Research and Monitoring Plan is important to help the Trustee Council plan for the wise and sustainable use of funds contained in the Restoration Reserve trust fund and to ensure that decision-makers plan the best possible strategy for continued, long-term research and monitoring.

C. Location

This project is a review of the draft Science Program and Research and Monitoring Plan the Exxon Valdez Oil Spill Trustee Council is preparing to guide long-term research and monitoring in the northern Gulf of Alaska, and thus deals with many locales.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

The committee charged to conduct this study will establish contact with the relevant communities so they are aware of our activity, most likely through the Public Advisory Group or the community liaisons. The study itself will have no direct impacts on the communities. When the final report is available, a summary will be made widely available, copies will be available through the National Academy Press, and the report will be posted in full on the National Academy of Sciences website. Current project information, including committee appointments and announcements of meetings, is also always available on the website.

PROJECT DESIGN

A. Objectives

This study will provide independent scientific guidance to the Trustee Council, research community, and public as the Trustee Council develops a comprehensive plan for a long-term, interdisciplinary research and monitoring program in the northern Gulf of Alaska. Specifically, the committee will:

- Gain, through briefings and literature review, familiarity with the relevant body of scientific knowledge, including but not limited to that developed by the research and monitoring activities sponsored by the Trustee Council in the past.

- Convene one or more information-gathering meetings in Alaska where researchers, the public, and other interested people can convey their perspectives on what the research and monitoring plan should accomplish.

- Review the general strategy proposed in the draft Science Program (which includes information on the social and political context, mission, approach, and scientific background) and make suggestions for improvement.

- Review -- once it is available -- the draft Research and Monitoring Plan, including the scope, structure, and quality of the approach proposed for a long-term research and monitoring program in the northern Gulf of Alaska. This will include whether the conceptual foundation provides an adequate basis for long-term research and monitoring, and whether the research and monitoring plan adequately addresses gaps in the knowledge base and existing uncertainties. The committee will also address broader issues related to overall effectiveness of the Trustee Council's program and plan for guiding continued efforts to understand biological change in the Gulf of Alaska.

The committee will convey its guidance in two products: first, it will prepare a short interim report commenting on the draft Science Program. After that, when the draft Research and Monitoring Plan is available, the committee will provide a final report containing more comprehensive comments and recommendations to guide the Trustee Council and the public in decision-making about the design and implementation of a long-term research and monitoring strategy for Prince William Sound and the northern Gulf of Alaska.

The committee will not examine land acquisition or habitat protection efforts, except where essential to its evaluation of the Science Program and the Research and Monitoring Plan.

B. Methods

This study will be conducted by a multidisciplinary committee of approximately 12 members that includes experts in a variety of relevant fields such as ecology, biological oceanography, fisheries biology, intertidal communities, marine mammal biology, ornithology, population dynamics, environmental assessment, cold water oil spill chemistry and impacts, environmental restoration, and long-term research and monitoring. Committee members serve as volunteers, receiving reimbursement for travel and direct expenses only. They will be selected by the Academy to bring disciplinary expertise and a diversity of experience and perspectives; no members will have ties to parties involved in related litigation. Nominations for committee members will be sought from the involved boards, the National Academy of Sciences and the National Academy of Engineering, the Trustee Council, the research community, and relevant agencies and nongovernmental organizations. All members will be subject to standard NRC procedures regarding bias and conflict of interest.

The committee will meet 6 times over an 20 month period, first to become familiar with existing research activities and then to review the draft Science Program and the draft Research and Monitoring Plan, and to foster communications with the people and the region to be served by the program and plan. The committee may seek assistance from experts not on the committee to help understand past activities or context. Close and timely coordination with the Trustee Council staff will be necessary so the committee's review is timed to meet the Council's needs and for assistance in locating materials and information.

From its information-gathering activities and deliberations, the committee will develop an interim and final report with conclusions and recommendations about the draft plan for future long-term monitoring and research in the Gulf of Alaska. The report development process will conform fully with the review procedures of the NRC.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Not applicable.

SCHEDULE

A. Measurable Project Tasks

FY 2000 (October 1, 1999 – September 30, 2000)

November 1999:	Funds awarded. Informed that availability of GEM plan would be delayed until spring 2000.
January – March 2000:	Committee selection process (nominations, investigate suitability, interviews, preliminary discussion of possible conflict of interest issues).
April 2000:	Committee slate announced and posted for public comment

	period. Draft Science Program to be conveyed to committee.
May-June 2000:	First meeting: orientation to history of program and to Science Program; information-gathering activities.
September 2000:	Second meeting: information-gathering activities, deliberation on Science Program.

FY 2001(October 1, 2000 – September 31, 2001)

November 2000:	Third meeting: deliberations; finalize interim report.
Dec - Jan 2000/01:	Interim report to outside review; response to review; Academy approval process.
February 2001:	Interim report delivered and discussed
March 2001:	Trustee Council to deliver the Research and Monitoring Plan
April 2001:	Fourth meeting: information gathering activities; deliberations on the Research and Monitoring Plan
June 2001:	Fifth Meeting: deliberations on the Research and Monitoring Plan
August 2001:	Sixth Meeting: report-writing workshop; finalize conclusions and recommendations.
September 2001:	Final report submitted for Academy outside review process.

FY 2002 (October 1, 2001 – January 31, 2002)

October 2001:	Response to review
November 2001:	Final revisions; Academy approval process
November 2001:	Report delivery (prepublication copies) with dissemination activities as needed.
January 2002:	Published volume available.

B. Project Milestones and Endpoints

In the first three meetings, the committee will gain an overview of the research and monitoring activities conducted to date, be briefed by interested parties in Alaska, and become familiar with the content of the draft Science Program sufficient to produce an interim report. At the fourth meeting, dependent on availability of the Research and Monitoring Plan from the Trustee Council, the committee will begin deliberations on the Research and Monitoring Plan. This will include whether the conceptual foundation provides an adequate basis for long-term research and monitoring, and whether the research and monitoring plan adequately addresses gaps in the knowledge base and existing uncertainties. The committee will also address broader issues related to the overall effectiveness of the Trustee Council's program and plan for guiding continued efforts to understand biological change in the Gulf of Alaska.

C. Completion Date

The committee's final report will be delivered to the Trustee Council and released to the public in November 2001. The delivery of the interim report in February 2001 will be in lieu of the required April 15, 2001 annual report. The delivery of the final published report will be in lieu of the required April 15, 2002 annual report.

PUBLICATIONS AND REPORTS

According to standard Academy operating procedures, no drafts or portions of the report will be conveyed; the final report will be submitted after it has completed the full Academy review process, expected by November 2001. The committee will provide periodic progress reports, noting the committee's activities and process. Reports resulting from this effort shall be prepared in sufficient quantity to ensure their distribution to the sponsor and to other relevant parties in accordance with Academy policy. Reports will be made available to the public without restrictions.

PROFESSIONAL CONFERENCES

This proposal contains a request for travel funds for the committee chair (or a delegated committee member) and study director to attend the 2001 and 2002 Restoration Workshops.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will help the Trustee Council in its efforts to synthesize the lessons learned from the extensive research efforts conducted to date, and apply those lessons to the draft science plan.

PROPOSED PRINCIPAL INVESTIGATOR

This study will be conducted by a volunteer committee composed of scientists with expertise in ecology, biological oceanography, fisheries biology, intertidal communities, marine mammal biology, ornithology, population dynamics, environmental assessment, cold water oil spill chemistry and impacts, environmental restoration, and long-term research and monitoring. The committee will be put together using standard NRC procedures to identify and select candidates. Final selection of members remains the responsibility of the Executive Office of the National Research Council.

The staff officer responsible for the activity will be:

Chris Elfring, Director
Polar Research Board (HA 454)

National Research Council
National Academy of Sciences, National Academy of Engineering
2101 Constitution Avenue NW
Washington, DC 20418
202-334-3426
202-334-1477
celfring@nas.edu

Additional staffing will be provided by:

David Policansky, Associate Director
Board on Environmental Science & Toxicology
National Research Council
National Academy of Sciences, National Academy of Engineering
2101 Constitution Avenue NW
Washington, DC 20418

OTHER KEY PERSONNEL

This activity will be conducted by a committee of experts appointed specifically for the described tasks, following normal Academy procedures. These committee members are responsible for the substantive content of their advice. Oversight for the study will be provided by the Polar Research Board and all other regular levels of Academy oversight.

OTHER RELEVANT INFORMATION

FEDERAL ADVISORY COMMITTEE ACT (FACA)

The Academy has developed interim policies and procedures to implement Section 15 of the Federal Advisory Committee Act, 5 U.S.C. App. § 15. Section 15 includes certain requirements regarding public access and conflicts of interest that are applicable to agreements under which the Academy, using a committee, provides advice or recommendations to a Federal agency. In accordance with Section 15 of FACA, the Academy shall submit to the government sponsor(s) following delivery of each applicable report a certification that the policies and procedures of the Academy that implement Section 15 of FACA have been substantially complied with in the performance of the contract/grant/cooperative agreement with respect to the applicable report.

Public Information About the Project:

In order to afford the public greater knowledge of Academy activities and an opportunity to provide comments on those activities, the Academy may post on its website (http://www.national-academies.org) the following information as appropriate under its procedures: (1) notices of meetings open to the public; (2) brief descriptions of projects;

(3) committee appointments, if any (including biographies of committee members); (4) report information; and (5) any other pertinent information.

The NRC will maintain a public access file containing copies of materials and data made available to the committee, so these are available to the public. Limited, selected materials such as drafts of their report and personal financial disclosure forms are not made public.

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 2000	Proposed FY 2001	LONG RANGE FUNDING REQUIREMENTS					
Personnel	$73,754.0	$89,621						
Travel	$103,890.0	$102,586						
Contractual	$12,721.0	$16,744						
Commodities	$600.0	$1,200						
Equipment	$0.0	$0						
Subtotal	$190,965.0	$210,151						
Indirect	$95,642.0	$105,829				Estimated FY 2002		
Project Total	$286,607.0	$315,980				$84,234		
Full-time Equivalents (FTE)	0.8	0.9						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:
Under contractural please note that we have included copying, technology, postage, phone charges, and meeting expenses. These are NOT necessarily contracted out.
Office supplies have been included under commodities.
Dissemination costs are included for the interim report which includes an editor, copies and postage.

NOTE: Due to change in project timeline, there will be a carryover of $90,150 from FY00 to FY01. Therefore, the requirements for year two will be $225,830.

FY01

Prepared: 4/4/2000

Project Number: ~~00~~ 01360
Project Title: Exxon Valdez Oil Spill Study
Name: The National Academies/Polar Research Board

FORM 4A
Non-Trustee
SUMMARY

2000 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 2001
Chris Elfring	Director, PRB		12.0	2777.0		33,324.0
David Policansky	Sr. Staff Officer, BEST		12.0	1809.6		21,715.2
Robert Greenway	Project Assistant		12.0	898.3		10,779.6
Toni Greenleaf	Administrative Associate		12.0	128.9		1,546.8
						0.0
	Fringe Benefits for above @ 26.86%					18,095.0
						0.0
Student Intern/TBD	Research/Staff Assistant		2.0	1600.0		3,200.0
Editor/TBD	Editor (3 days)		0.0			960.0
						0.0
						0.0
						0.0
	Subtotal		50.0	7213.8	0.0	
					Personnel Total	$89,620.6

Travel Costs:			Ticket	Round	Total	Daily	Proposed
Description			Price	Trips	Days	Per Diem	FY 2001
Anchorage	Workshop in Winter 2001 (2 committee/1staff)		1000.0	3	15	140.0	5,100.0
Anchorage	Committee Meeting/Data Gathering/Low Season		1000.0	17	68	140.0	26,520.0
TBD	Chair and Staff to discuss strategy for the committee						0.0
	report (Domestic rates negotiated		1148.0	2			2,296.0
	with ONR/combine air and per diem)						0.0
TBD	Writing Meeting/Not in Alaska		1331.0	15			19,965.0
	(Domestic rates negotiated with ONR/combine air and per diem)						0.0
Anchorage	Committee Meeting/Deliberations on plan/High Season		1000.0	15	60	229.0	28,740.0
TBD	Report-Writing Workshop/Full Committee		1331.0	15			19,965.0
	(Domestic rates negotiated with ONR/combine air and per diem)						0.0
							0.0
							0.0
						Travel Total	$102,586.0

FY01

Prepared: 4/4/2000

Project Number: 00360
Project Title: Exxon Valdez Oil Spill Study
Name: The National Academies/Polar Research Board

FORM 4B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2001
Photocopies	2,849.0
Postage/Delivery	1,504.0
Technology/Communications	6,251.0
Meeting Expense (room rental, breaks, transportation)	6,000.0
Publications/computer research/searches	140.0
Contractual Total	$16,744.0

Commodities Costs:	Proposed
Description	FY 2001
Office Supplies	1,200.0
Commodities Total	$1,200.0

FY01

Project Number: 00360
Project Title: Exxon Valdez Oil Spill Study
Name: The National Academies/Polar Research Board

FORM 4B
Contractual & Commodities DETAIL

Prepared: 4/4/2000

2000 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2001
			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	

FY01

Project Number: 00360
Project Title: Exxon Valdez Oil Spill Study
Name: The National Academies/Polar Research Board

FORM 4B
Equipment
DETAIL

Prepared: 4/4/2000

EXXON VALDEZ Oil Spill Trustee Council

FY 01 Detailed Project Description

Improved salmon escapement enumeration using remote video and time-lapse recording technology

RECEIVED
APR 14 2000
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

Project Number:	01366
Restoration Category:	Monitoring
Proposer:	ADF&G
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	
Alaska SeaLife Center:	No
Duration:	3rd year, 3-year project
Cost FY 1999:	$ 53,473
Cost FY 2000:	$ 46.5 K
Cost FY 2001:	$ 12.4 K
Cost FY 2002:	$ 1.0 K*
Geographic Area:	Lower Cook Inlet
Injured Resource/Service:	salmon/commercial fishing

*Note: FY02 costs will only be incurred if $1000 page costs are not expended in FY01.

ABSTRACT

Salmon resources and services within the spill area, and particularly within Prince William Sound, were injured by the 1989 *Exxon Valdez* oil spill and have not yet fully recovered. To monitor the recovery of salmon stocks in the spill area and improve escapement information used to set spawning escapement goals, we propose to develop remote video and time-lapse recording technology for enumerating salmon escapement. Remote video has the potential to provide accurate, archivable documentation of salmon escapements well beyond the capacity of aerial survey indices, and well below the cost of weir and sonar projects. Videotapes can be retrieved and reviewed weekly to facilitate in-season management of commercial fisheries.

INTRODUCTION

Aerial survey has been used to monitor salmon escapement in clear streams throughout Alaska for over 35 years (Bevan 1961). This technique is favored for remote and marginally productive drainages which otherwise may go unassessed due to the high cost of intensive monitoring methods (e.g., weir, sonar) relative to the stream's modest escapement. However, aerial survey has several drawbacks. Observer experience, water clarity, stream morphology and habitat type, timing of survey flights, and stream residency are just a few factors shown to influence the accuracy and precision of aerial survey estimates of salmon escapement (see Bevan 1961, Evzerov 1981, Neilson and Geen 1981, Cousens et al. 1982, Shardlow et al. 1987, Perrin and Irvine 1990, Hill 1997, and Bue et al. 1998a). At best, aerial survey provides consistent indices of in-river escapement among years. It does not provide accurate, reliable estimates of spawner-abundance, particularly when in-river exploitation of salmon is high and observer efficiency and stream residency are not precisely known (Perrin and Irvine 1990, Bue et al. 1998a).

Accurate, reliable estimates of spawner abundance are required to monitor the recovery of damaged salmon resources, set appropriate spawning escapement goals for individual streams, and manage commercial fisheries in season. Because aerial survey cannot always provide this level of information and more accurate methods are prohibitively expensive for streams with marginal escapements, a niche exists that remote video technology may be able to fill. Fishery biologists have long considered the potential for photographic enumeration to eliminate the biases inherent to human derived aerial and tower counts of salmon escapement. In the late 1940's and early 1950's, researcher's experimented with aerial and tower based photography to count sockeye salmon in the Bristol Bay area (see Kelez 1947, Eicher 1953, and Mathisen 1962). While these early experiments showed promise, their feasibility was reduced by the state of technology of cameras and recording equipment from this era.

Many technological advancements have occurred since that time and recent video and time-lapse recording systems have proven effective for capturing remote images of adult (Hatch et. al 1994) and juvenile salmonids in controlled field situations (Irvine et. al 1991). In Chignik, Alaska, researchers are using underwater video equipment to facilitate enumeration of adult salmon passing a deep-water weir (Dave Owens, ADF&G Kodiak, personal communication). The Chignik system is powered by a gas generator and maintained by a field crew. In the Pacific Northwest, researchers are experimenting with stand-alone underwater video systems associated with partial weirs (P. Mundy, P. Mundy and Assoc., personal communication). An unmanned underwater system is not practical for most Alaskan streams because the camera would be vulnerable to inquisitive bears and other mammals. In FY99 we propose to develop an unmanned

video system that can be deployed above small streams, out of the reach of bears. The video system will document sockeye, pink, and coho salmon escapement into Delight Lake. Time-lapse images will be recorded onto a VCR powered by 12-volt batteries. Solar and hydropower generators will maintain the batteries. A weir will be operated concurrently to determine the accuracy of video counts. In FY00 we will evaluate the camera's performance counting pink and chum salmon escapement in a short, intertidal stream.

NEED FOR THE PROJECT

A. Statement of Problem

Salmon resources and services were injured by the 1989 *Exxon Valdez* oil spill. Accurate, reliable estimates of spawner abundance are required to monitor the recovery of damaged salmon resources, set appropriate spawning escapement goals for individual streams, and manage commercial fisheries in season. Aerial survey estimates of spawning escapement are often biased by conditions (e.g., observer experience/efficiency, timing of flights, etc.) that are difficult to account for, leading to imprecise indices of spawning escapement. Because accurate escapement monitoring is so important for salmon management and documenting the recovery of salmon resources and services, reliable, cost-effective techniques should be developed to improve escapement estimation where aerial survey is currently used.

B. Rationale/Link to Restoration

Salmon resources throughout the spill area, and particularly in Prince William Sound (Bue et al. 1996, Bue et al. 1998b) were damaged by the 1989 *Exxon Valdez* oil spill (EVOS) and have not fully recovered (1998 EVOS Trustee Council Status Report). This project has potential for improving long-term monitoring and management of salmon stocks within the spill area and statewide. Improved escapement monitoring will enable more effective evaluation of recovery efforts. It will also facilitate improved in-season management of fisheries, which will help restore injured sport and commercial fishing services.

C. Location

Development of this improved escapement monitoring technology will occur in Lower Cook Inlet (Southern Kenai Peninsula). However, project benefits could be realized throughout the spill area

and anywhere in Alaska where aerial survey is currently being used to monitor salmon escapement in small, clear streams.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Although McCarty Fiord and much of the Kenai Peninsula's outer coast is contained within Kenai Fiords National Park (KFNP), Delight Lake and its outlet stream (Delight Creek) are owned by the Port Graham Corporation (PGC). Port Graham residents report a long history of using these salmon resources for commercial and subsistence purposes and are concerned for the area's continuing productivity. Although the remote video system could be evaluated elsewhere, a unique opportunity exists at Delight Lake to fulfill PGC and KFNP requests to provide improved monitoring of salmon escapement and production.

PROJECT DESIGN

A. Objectives

1. (FY99): Determine the accuracy and reliability of a remote video system for estimating sockeye salmon escapement in small streams, and
2. (FY00): Determine the accuracy and reliability of a remote video system for estimating pink and chum salmon escapement in tidally influenced streams where intertidal spawning occurs.

B. Methods

Not applicable- report writing only; no field or lab activities (closeout year).

C. Cooperating Agencies, Contracts, and other Agency Assistance

Not applicable

SHEDULE

A. Measurable Project Tasks for FY99

October-January:	Purchase video equipment and associated materials.
January-April:	Fabricate strongbox for video equipment; arrange logistics for field camps and weir installation.
June:	Deploy camp, weir, and video equipment.
June-August:	Operate weir camp, maintain camera equipment, review tapes.
September:	Evaluate camera's performance against weir counts.

B. Measurable Project Tasks for FY00

November:	Present first year results at AFS meeting in Kodiak.
January-April:	Present poster at Annual EVOS workshop; turn in EVOS Annual Report, DPD, and budget for FY01 activities.
Late June:	Deploy camp, weir, and video equipment.
July-August:	Operate weir camp, maintain camera equipment, review tapes.
September:	Evaluate camera's performance against weir counts

C. Measurable Project Tasks for FY01

November 2000:	[1]Present second year results at AFS meeting in Fairbanks.
January-April 2001:	Present poster at Annual EVOS workshop; turn in EVOS draft final report for review.
May-September 2001:	Complete any necessary revisions of EVOS final report. [2]Prepare and possibly submit manuscript for publication

[1]If analyses can be completed in time and it fits into the PI's schedule.

[2]The PI will attempt to complete the manuscript before the end of FY01, but submittal and page costs may get deferred to FY02.

D. Project Milestones and Endpoints

September 1999	Objective 1:	Determine video system's accuracy and reliability by comparing video counts against weir counts.
September 2000	Objective 2:	Determine feasibility of using remote video to count pink and chum salmon escapement in tidally influenced streams.

September 2001 Obj. 1-2: Complete project final report.

E. Completion Date

All project objectives will have been met by the end of FY00 and the project will close out in FY01. If remote video proves to be a reliable and cost-effective method for improving upon aerial survey estimates of spawning escapement, ADF&G may use normal agency funding to replace aerial surveys with video, where suitable. The ADF&G may also pursue development of microwave technology to transmit digital images directly to field stations, and image-recognition software to facilitate auto-enumeration.

PUBLICATIONS AND REPORTS

Internal (ADF&G) and external (EVOS Trustee Council, Chief Scientist, etc.) peer review of project documents (DPD, Annual and Final Reports) will occur throughout the project's duration. In April FY01, we will submit our Project Final Report. The PI also may choose to submit a manuscript for publication at that time, as partial fulfillment of his final reporting requirements to the EVOS TC. If a manuscript cannot be completed by April FY01, the PI plans to submit one for publication in FY02. Our intention is to submit an article entitled "Reliability and performance of a remote video system for monitoring salmon escapement in Alaska", most likely to Transactions of the American Fisheries Society or the North American Journal of Fisheries Management. Page costs have been requested in our FY01 budget, but these costs may get deferred to FY02 if the manuscript is not published by September 2001.

PROFESSIONAL CONFERENCES

Travel funds have been requested to attend the EVOS annual workshop in Anchorage, where we plan to present a poster. If analyses can be completed in time, FY00 results may be presented at the 2000 Annual Meeting of the Alaska Chapter of the American Fisheries Society, held in Fairbanks in November. If the PI's schedule does not allow this, that portion of the requested travel funds will not be spent.

NORMAL AGENCY MANAGEMENT

Along with monitoring the recovery of injured resources, the proposed project will improve the department's ability to assess and manage salmon resources within the spill area and elsewhere in Alaska. The department has few resources with which to develop new technology; without the Trustee Council's financial support, this project will not be funded in the near future. A unique opportunity exists for the EVOS Trustee Council to add to their legacy by supporting ADF&G's development of a new salmon counting technique that is likely to improve salmon management throughout Alaska.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The PI has presented our FY99 results at two professional meetings, including one with scientists from other disciplines (EVOS Workshop). Our intention was to advertise remote video's potential for improving restoration and monitoring efforts of fish and wildlife resources. Partly through attendance at these meetings, we have maintained an active dialogue with other professionals interested in remote video applications (e.g., Arthur Kettle, USFWS, Barren Islands seabirds; Mike O'Meara, Pratt Museum, seabirds; Kathy Frost, ADF&G, PWS harbor seals, and Daniel Zatz, SeeMore Wildlife, Chiswell Island sea lions). Following the successful completion of this evaluation study, the PI may solicit professionals in other disciplines to submit a joint proposal to include remote video technology in the GEM Program.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

Does not apply.

PROPOSED PRINCIPAL INVESTIGATOR

Edward O. Otis
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3298 Douglas Place
Homer, AK 99603
(907) 235-1723
(907) 235-2448

ted_otis@fishgame.state.ak.us

PRINCIPAL INVESTIGATOR

Edward O. Otis, Asst. Area Research Biologist for Lower Cook Inlet, Alaska Department of Fish and Game, Commercial Fisheries Division (CF), 3298 Douglas Place, Homer, AK 99603. **Education**: Master of Science, Fisheries Science, University of Arizona, 1994. Bachelor's of Science, Environmental Science, University of New Hampshire, 1988. **Professional Experience:** April 1996-present: Asst. Area Research Biologist for Lower Cook Inlet, Alaska Department of Fish and Game, CFMD, Homer, AK. Supervised by William R. Bechtol. Responsible for assessment and forecasting of Kamishak Bay herring stock; directs salmon and herring catch/escapement-sampling programs; forecasts Lower Cook Inlet salmon returns. April 1994-March 1996: Fishery Biologist, Kenai Fishery Resources Office, U.S. Fish and Wildlife Service, Kenai, AK. Supervised by Gary Sonnevil. Project leader for Andreafsky River (Yukon) adult salmon enumeration project: constructed and deployed resistance board/floating weir to count adult salmon; project leader for Kenai River rainbow trout radio-telemetry project: surgically implanted radio transmitters and tracked fish using mobile receivers and remote data loggers. June 1991-March 1994: Graduate Research Asst., Univ. of Arizona, Dept. of Renewable Natural Resources, Tucson, AZ. Supervised by Dr. O. Eugene Maughan. Designed and implemented field studies to assess the composition, abundance, and distribution of fishes in streams tributary to the Colorado River in Grand Canyon. Designed and implemented field study to inventory aquatic habitat available to stream fishes in Grand Canyon. August 1987-June 1991 (intermittent): Field biologist/technician, Kenai Fishery Resources Office, U.S. Fish and Wildlife Service, Kenai, AK. Supervised by Gary Sonnevil. Project Leader or team member on various field projects including: assessing adult salmon returns using weirs (Uganik R, Kodiak); developing new approaches to aging dolly varden and lake trout otoliths; enumerating emergent salmon fry (Tustumena Lake); investigating steelhead distribution and angler effort (Cold Bay); investigating run-timing and migration rates of chinook salmon (Kuskokwim River); and inventorying salmon spawning habitat (Ayakulik R., Kodiak).

Selected Publications:

Weiss, S.J., **E.O. Otis**, and O.E. Maughan. 1998. Spawning ecology of flannelmouth sucker *Catostomus latipinnis* (Catostomidae) in two small tributaries of the lower Colorado River. Environmental Biology of Fishes.

Otis, E.O. and W.R. Bechtol. 1997. Forecast of the Kamishak herring stock in 1997. Alaska Dept. of Fish and Game, Regional Information Report No. 2A97-03.

Otis, E.O. 1997. Lower Cook Inlet pink salmon forecast for 1997. Alaska Department of Fish and Game Regional Information Report No. 2A97-09.

Otis, E.O., W.R. Bechtol, and W.A. Bucher. 1998. Coping with a challenging stock assessment situation: the Kamishak Bay sac-roe herring fishery. In Proceedings of the International Stock Assessment Symposium, 1997 Lowell Wakefield Conference (*in press*).

Otis, E.O., W.R. Bechtol, and W.A. Bucher. 1998. Abundance, age, sex, and size statistics for sockeye salmon in Lower Cook Inlet, 1995. Alaska Department of Fish and Game Regional Information Report No. 2A98-07.

Otis, E.O., and M.S. Dickson. 1999. Abundance, age, sex, and size statistics for sockeye, chum, and pink salmon in Lower Cook Inlet, 1996. Alaska Department of Fish and Game Regional Information Report No. 2A99-09.

OTHER KEY PERSONNEL

Project Manager: Mark Dickson, Fish and Wildlife Technician IV. Mr. Dickson has been employed as a fish culturist and fish and wildlife technician with the Alaska Department of Fish and Game for the past 20 seasons. He has considerable experience managing salmon escapement related field projects, including: the *EVOS* Trustee Council funded Delight and Desire Lakes project (97254) and currently, the Port Dick Creek Restoration project (97139A2).

LITERATURE CITED

Bevan, Donald E. 1961. Variability in aerial counts of spawning salmon. Journal of the Fisheries Research Board of Canada 18(3):337-348.

Bucher, W.A., and L.F. Hammarstrom. 1997. 1996 Lower Cook Inlet annual finfish management report. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Anchorage.

Bue, B. G., S. Sharr, S.D. Moffitt, and A. Craig. 1996. Effects of the Exxon Valdez oil spill on pink salmon embryos and preemergent fry. Pages 619-627 *in* Rice et al. (1996).

Bue, B.G., S.M. Fried, S. Sharr, D.G. Sharp, J. Wilcock, and H.J. Geiger. 1998a. Estimating salmon escapement using area-under-the-curve, aerial observer efficiency, and stream-life estimates: the Prince William Sound pink salmon example. North Pacific Anadromous Fisheries Commission Bulletin 1:240-250.

Bue, B. G., S. Sharr, and J.E. Seeb. 1998b. Evidence of damage to pink salmon populations inhabiting Prince William Sound, Alaska, two generations after the *Exxon Valdez* oil spill. Transactions of the American Fisheries Society 127:35-43.

Cousens, N.B.F., G.A. Thomas, D.G. Swann, and M.C. Healey. 1982. A review of salmon escapement techniques. Canadian Technical Report of Fisheries and Aquatic Sciences 1108:129 pp.

Dickson, M., W. Bucher, and G. Coble. 1999. Tributary restoration and development project: Port Dick Creek, Lower Cook Inlet, Alaska, Exxon Valdez oil spill restoration project 1998 annual report (Restoration Project 98139-A2), Alaska Department of Fish and Game, Homer, Alaska.

Edmundson, J., M. Dickson, and W. Bucher. 1998. Limnology and fishery investigations concerning sockeye salmon production in Delight and Desire lakes, EVOS Restoration Project 97254 Final Report submitted by the Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development.

Eicher, G.J. 1953. Aerial methods of assessing red salmon populations in western Alaska. Journal of Wildlife Management 17(4):521-527.

Evzerov, A.V. 1981. An evaluation of the errors occurring in salmon census by aerial survey. Canadian Translations of Fisheries and Aquatic Sciences 4714:1-5. Translated from Salmonidae of the Far East, 1975 CVI:82-84.

Hatch, Douglas R., M. Schwartzberg, and P.R. Mundy. 1994. Estimation of pacific salmon escapement with a time-lapse video recording technique. North American Journal of Fisheries Management 4:626-635.

Hatch, D.R., J.K. Fryer, M. Schwartzberg, D.R. Pederson, and A. Wand. 1998. A computerized editing system for video monitoring of fish passage. North American Journal of Fisheries Management 18: 694-699.

Hill, R.A. 1997. Optimizing aerial survey count frequency for the area-under-the-curve method of estimating escapement. North American Journal of Fisheries Management 17:461-466.

Irvine, J.R., B.R. Ward, P.A. Teti, and N.B.F. Cousens. 1991. Evaluation of a method to count and measure live salmonids in the field with a video camera and computer. North American Journal of Fisheries Management 11:20-26.

Kelez, G.B. 1947. Measurement of salmon spawning by means of aerial photography. Pacific Fisherman 45:46-51.

Mathisen, O.A. 1962. Photographic enumeration of red salmon escapement. Pages 349-372 in Koo, T.S.Y (ed.) Studies of Alaska Red Salmon. Univ. of Wash. Publ. In Fish. New Ser. 1: 449 pp.

Neilson, J.D. and G.H. Geen. 1981. Enumeration of spawning salmon from spawner residence time and aerial counts. Transactions of the American Fisheries Society 110:554-556.

Perrin, C.J. and J.R. Irvine. 1990. A review of survey life estimates as they apply to the area-under-the-curve method for estimating the spawning escapement of Pacific salmon. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1733. 49 pp.

Shardlow, T., R. Hilborn, and D. Lightly. 1987. Components analysis of instream escapement methods for Pacific salmon (Oncorhynchus spp.). Canadian Journal of Fisheries and Aquatic Sciences 44:1031-1037.

2001 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001	LONG RANGE FUNDING REQUIREMENTS					
Personnel	$28,000.0	$6.90						
Travel	$1,500.0	$2.20						
Contractual	$4,370.0	$2.10						
Commodities	$1,825.0	$0.0						
Equipment	$6,500.0	$0.0						
Subtotal	$42,195.0	$11.2				Estimated FY 2002		
General Administration	$4,300.0	$1.2						
Project Total	$46,495.0	$12.4				$1.0		
Full-time Equivalents (FTE)	0.5	0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Note: The $1,000 estimated for FY02 is for page costs and will only be needed if page costs budgeted for FY01 are not expended (i.e., if a manuscript is not ready for publication by September 2001, we intend to submit one in FY02).

FY01

Prepared:

Project Number: 01366
Project Title: Improved salmon escapement enumeration using remote video and time-lapse recording technology
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRI E COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2001
						0.0
						0.0
Mark Dickson (or equivelant)	Fish and Wildlife Technician IV	13J	1.5	4600.0		6,900.0
						0.0
	Assistance in preparing the final report and manuscript for publication					0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.5	4600.0	0.0	
					Personnel Total	$6,900.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2001
Annual EVOS Restoration Workshop					0.0
Homer-Anchorage and return (for PI and Project Manager).	180.0	2	6	42.0	612.0
Lodging			3	130.0	390.0
					0.0
Annual Alaska Chapter AFS Meeting in Fairbanks					0.0
Homer-Fairbanks and return (for Project PI)	500.0	1			500.0
Food per diem- 1 person for 3.5 days			4	42.0	168.0
Lodging- 1 person for 3 nights			3	150.0	450.0
Registration Fee					100.0
					0.0
					0.0
					0.0
				Travel Total	$2,220.0

FY01

Prepared:

Project Number: 01366
Project Title: Improved salmon escapement enumeration using remote video and time-lapse recording technology
Agency: Alaska Department of Fish and Game

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed FY 2001
Description	
Page costs for publication of project results in a professional journal. A suggested journal and article title are: Transactions of the Amercian Fisheries Society "Reliability and performance of a remote video system for monitoring salmon escapement in Alaska" Comment: As noted in the FY01 DPD, we will attempt to complete and submit this manuscript by September 2001, however, submission and page costs may get deferred to FY02 if this schedule cannot be met.	1,000.0
Photo developing and digitizing, graphic art design, poster costs, etc.	1,100.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$2,100.0

Commodities Costs:	Proposed FY 2001
Description	
Commodities Total	$0.0

FY01

Prepared:

Project Number: 01366
Project Title: Improved salmon escapement enumeration using remote video and time-lapse recording technology
Agency: Alaska Department of Fish and Game

FORM 3B
Contractual & Commodities
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2000 - September 30, 2001

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2001
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Personal computers	2	ADF&G

FY01

Project Number: 01366
Project Title: Improved salmon escapement enumeration using remote video and time-lapse recording technology
Agency: Alaska Department of Fish and Game

FORM 3B
Equipment
DETAIL

Prepared:

Effects of Harbor Seal Metabolism on Stable Isotope Ratio Tracers

Project Number:	01371
Restoration Category:	Research
Proposer:	University of Alaska Fairbanks
Lead Trustee Agency:	ADFG
Cooperating Agencies:	None
Alaska SeaLife Center:	yes
Duration:	3rd year, 3-year project
Cost FY 00:	$98,000
Cost FY 01:	$86,751
Geographic Area:	Prince William Sound/Gulf of Alaska
Injured Resource/Service:	Harbor seals

ABSTRACT

A major concern when using stable isotope tracers in ecosystem studies is the fidelity with which isotope ratios are transferred up food chains. Use of specific habitats or prey cannot be assessed because geographic gradients in isotope ratios confound trophic effects and/or prey switching. To remove these problems, we developed complex analytical protocols to isolate amino acids from harbor seals which were pulse-labeled with ^{15}N-amino acids. Subsequent samples of blood plasma and red blood cells over time allowed for estimation of nitrogen incorporation rates. The goal of the final year is to identify pathways of rapid versus slower turnover. Determination of habitat biomarkers will be investigated in year 3 of the project.

INTRODUCTION

Stable isotope ratios have become an essential tool in the study of living organisms and their physiology. The hazards of handling radioisotopes and severe protocol requirements when using live organisms have resulted in a steadily increasing shift to the use of stable isotopes as tracers for both human and animal subjects. Some usage such as the detection of *Helicobacter pylori* infections in ulcer patients are now routine and bringing stable isotope analysis to many hospitals as a standard method. In contrast to the employment of natural abundance techniques in the marine environment, most physiology experiments employ compounds enriched with ^{13}C or ^{15}N to enhance detectability and to follow the transfers to different metabolites within the organism. Improved lower limits of detectability and smaller sample size requirements now allow the use of stable isotopes where only radioisotopes would have worked in the past.

This proposal describes continuing experiments underway at the Alaska SeaLife Center (ASLC) and at the University of Alaska Fairbanks (UAF) to provide calibration and more detailed information on stable isotope transfers and fractionation in marine mammals (and perhaps sea birds in the future). This will enable better interpretation of natural abundance isotope data acquired in Prince William Sound and the adjacent Gulf of Alaska. Coordination with the studies of Dr. M. Castellini who is conducting feeding experiments and dietary studies at ASLC will lead to a thorough integration of efforts and optimization of the use of animal subjects in all years of the study. Year 1 has consisted of the refinement of analytical techniques isolating amino acids and will test for the presence of essential amino acids in harbor seals at ASLC. Succeeding years will focus on the search for biomarkers useful in identification of specific habitat usage and as indicators of the assimilation of various species of forage fishes.

Over the past two decades, isotope ratio analysis has emerged as a powerful tool in ecosystem research, both on the process scale and as a validation technique for large-scale ecosystem models (Michener and Schell, 1994). In relevant applications to this study, Saupe et al (1989) and Schell et al. (1989) described a geographic gradient in isotope ratios in biota across the Alaskan Beaufort Sea and the Bering–Chukchi seas and showed that this gradient could be applied to describing bowhead whale natural history. The isotopic gradient arises from the primary producers in the ecosystem and is passed up food chains to label consumers up to the top predators. Within each biome, there is reasonable fidelity to the $\delta^{13}C$ observed in the primary producers and a predictable increase in the $\delta^{15}N$ with each known increase in trophic level. However, among individuals of each taxon analyzed there are often large ranges in values, especially in the carbon isotope ratios.

A fundamental assumption in the employment of isotope ratios as natural tracers is that the amount of isotopic fractionation in the process of metabolizing food is known during the incorporation of assimilated components into the consumer. For marine mammals, these data are scarce and most of the ongoing work is based on the findings derived from terrestrial bird and mammal studies. The accurate interpretation of isotope ratio data on food webs and marine mammals depends completely on knowledge of fractionation effects arising from dietary sufficiency and composition. To date, we do not have this knowledge because it has become evident that there exist marked geographic gradients in isotope ratios in Prince William Sound and the Gulf of Alaska. This project is thus aimed at the goal of identifying specific biomarker molecules and acquiring accurate isotope fractionation data on harbor seals through controlled feeding and laboratory experiments. This project will be thoroughly integrated with ongoing

research on harbor seals at the ASLC and will be complementary to the physiological research projects in progress.

NEED FOR THE PROJECT

A. Statement of Problem

Harbor seals were undergoing an unexplained decline in numbers before the oil spill and the decline was further accelerated by the disaster. Since that time the population has not recovered and is still at a low level, although now perhaps finally stabilized. No definitive cause and effect relationships have been found for the decline or failure to recover. It is becoming increasingly evident, however, that change in the marine environment in the past two decades has altered the carrying capacity downward in the northern Gulf of Alaska and the effects are being felt to top of the food chains. Carbon isotope ratios in biota of the northern Pacific Ocean appear to have been declining for nearly twenty years (Schell, in preparation) and imply that a major decrease in productivity has occurred. Isotope ratios from wild seals also show changes over time in the isotope ratios but the interpretation requires knowledge of both the fractionation that occurs during assimilation and the natural variations arising from migratory movements. If one or more essential amino acids can be identified in the diet of seals, these would allow a conservative tracer independent of isotope fractionation effects arising from metabolism. There are almost no data regarding marine mammals on this subject and none on harbor seals. This study will undertake to follow both the "whole animal" carbon and nitrogen isotopic fractionation and the determination of specific biomarkers arising from diet that would allow clearer insight into dietary dependencies.

B. Rationale/Link to Restoration

Carbon isotope ratios serve as conservative tracers of energy supply between trophic levels (phytoplankton to zooplankton to fishes to top consumers). Seals, cetaceans, birds, etc. acquire the isotope ratios in proportion to the amount of food derived from each differing source. This, in turn, is reflected in the composition of body tissues and in keratinous tissues (claws, feathers, baleen, whiskers) as a temporal record when multiple sources of food are consumed over time and space. This allows the discerning of important habitats and food resources in animals such as harbor seals that seasonally migrate or undergo periods of hyper- and hypotrophy. Little is known, however, of the internal fractionation of isotopes that occurs in mammals during fasting and/or extended periods of suboptimal diets. Current experiments on the effects of differing diets on captive harbor seals conducted at the ASLC provide an ideal opportunity to enhance the physiological data gained by investigating the efficiency of amino acid transfers in diets and the presence of essential amino in pinnipeds.

Nitrogen isotope ratios reflect both the food sources and the trophic status of that animal. As nitrogen in food is consumed and assimilated by a consumer, the heavy isotope is enriched by approximately 3 ‰, with accompanying loss of the lighter isotope through excretion. The enrichment occurs with each trophic step and thus allows the construction of conceptual models and food webs and the assignment of relative trophic status to species for which dietary data are sparse. Hobson and Welch (1992) used isotope ratios to describe the trophic relationships of birds and mammals to the available prey species in the Canadian Arctic. Further extension to

benthos by Dunton et al. (1991) and to fishes (Vinette, 1992) has confirmed that the isotopic trends are evident across the entire food web. During fasting or starvation, nitrogen isotopes may be fractionated during transamination reactions leading to overall shifts in the average isotope ratios of the whole animal. Best and Schell (1996) observed, for example, that ^{15}N enrichment in southern right whales evidenced during winter breeding season in South African waters when carbon isotope ratios revealed that very little feeding occurred. Detailed interpretation of data from samples taken from wild seals requires that these effects be known.

C. Location

The research efforts are underway at the Alaska SeaLife Center and the University of Alaska Fairbanks. The instrumental analyses, specifically the development of the amino acid isolation protocols, has been conducted at UAF on samples collected during the dietary studies and sampling at ASLC by Dr. Castellini's group. We are now performing the isolations of both derivatized and free amino acids from seal samples and conducting the mass spectrometry.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Much of the research will be conducted at the Alaska SeaLife Center and the Principal Investigator anticipates both community interaction and explanation of the research approach and usefulness at the site.

PROJECT DESIGN

A. Objectives

The null hypotheses to be tested are as follows:

1. The isotope ratios of harbor seals accurately reflect diet under all conditions. Increased fractionation does not occur during periods of fasting or suboptimal feeding and does not affect either carbon or nitrogen isotope ratios in harbor seals.

2. There are no essential amino acids in harbor seals and their prey that can act as conservative markers of specific habitats of food sources or of specific prey species.

The objectives of this study are divided into three elements, which have been modified as the study progressed:

1. Year 2, now underway, consists of developing methods and protocols for the isolation of metabolites from harbor seal blood and tissue samples to be employed during the following controlled diet studies. The Institute of Marine Science has purchased a new GC-IRMS (gas chromatograph–isotope ratio mass spectrometer) that has been used to determine isotope ratios in the individual amino acids isolated from serum samples. These amino acids are separated using high performance liquid chromatography using semi-preparative columns and inorganic buffers. Testing for essential amino acids in harbor seals has been initiated using blood samples acquired from seals being used by Dr. Michael Castellini for food

assimilation efficiency studies. By feeding ^{15}N and ^{13}C-labeled glycine to the seals prior to blood sample collection, it will be evident if the label has been transaminated to amino acids and to what extent. If some amino acids remain unlabeled, the corresponding labeled amino acid will be administered to see if transamination occurs in the reverse direction. Conservative amino acids will be prime candidates for environmental biomarkers.

2. The second component will be a study of the effects of suboptimal versus optimal diet on the fractionation of carbon and nitrogen isotopes in harbor seals. Diets of known amount and composition (isotopic and energetic) are being fed to the seals at ASLC and blood samples are being monitored for composition and isotope ratios. Dr. M. Castellini is closely coordinating this research with studies of controlled diet/assimilation efficiencies in harbor seals so that minimal animal handling and sampling will be necessary. The first trial of the feeding study began in December 1998 and the second will commence in May 2000.

3. The third component was to determine source prey for isotopically distinct fatty acids or other metabolites. The identification of specific fatty acids that carry a conservative signal to top consumers (birds, cetaceans, fissipeds) would yield an extraordinarily valuable tool to follow food web transfers or to identify specific habitat importance. This aspect of the work has also been undertaken by study 00441 and we have shifted our emphasis to the nitrogen metabolism and amino acids. Protocol development for amino acid mass spectrometry has taken longer than anticipated and we are planning intense effort over the remaining time on this aspect. If time allows we will undertake fatty acid extractions and identifications during the final year. Many of the prey species samples are already archived and analysis can begin as soon as primary goals are attained.

B. Methods

Isotopic Analysis of Blood Protein Amino Acids

The proteins and free amino acids in blood serum samples from captive harbor seals and muscle protein from native harvested seals are hydrolyzed with 0.6 N HCl in sealed ampoules to free proteinaceous amino acids. This procedure provides several essential amino acids for mammals but if time permits we will use multiple procedures to optimize amino completeness, such as acid and basic hydrolysis. An investigation of the use of proteolytic enzymes is no longer being considered because of time constraints. Once isolated the free amino acids will be separated by HPLC (high performance liquid chromatography) either as derivatives of orthophthalaldehyde (OPA) or as underivatized amino acids. The latter procedure is preferable but will require modification of the HPLC system. This equipment for these modifications is on order and will be employed as they come online in late spring 2000. The aliquots with individual amino acids will be taken to dryness. These samples will then be run on an elemental analyzer coupled to the isotope ratio mass spectrometer and the nitrogen and carbon dioxide liberated in the elemental analyzer will be separated by gas chromatography and run individually in the IRMS. Preliminary data on seal amino acids are presented in the accompanying annual report.

In the past feeding experiment, we intravenously dosed 2 seals on different diets with ^{15}N-labeled glycine and the appearance of the label in the serum and red blood cells was followed over time in the total amino acid spectrum. This experiment has already demonstrated the in vivo appearance of the label and provided an approximate turnover time for free amino acids in the blood serum of the seals. Preliminary data are shown in the FY00 annual report. Samples of

the blood are currently being processed for individual amino acid analysis. Those amino acids remaining free of the label will be identified as probable essential amino acids derived solely from diet that would constitute conservative biomarkers. Mobilization and isotopic fractionation of these amino acids will be tested further in reverse dietary studies in summer 2000 wherein the labeled amino acid will be infused and the rate of transamination followed in feeding and fasting seals.

Isotope Fractionation During Fasting and Suboptimal Diets

Many marine mammals undergo periods of fasting or suboptimal diets such as during molt or reproduction. Nothing is known regarding the effects of these periods on the fractionation of either carbon or nitrogen isotopes in harbor seal tissues. The amino acid threonine, for example, has been shown to become very isotopically depleted in ^{15}N during starvation, with lesser effects on glycine and serine (Hare et al., 1991). In coordination with studies of dietary effects on blood hormones or other work requiring harbor seal blood samples at ASLC, we will analyze aliquots as described above for shifts in the isotope ratios. We have completed collection of blood samples from unlabeled seals (used as controls in the experiments), which showed shifts in the natural abundance of isotope ratios over the feeding experiment with constant diet. These physiologically induced shifts probably arise from mobilization of amino acids in molting or onset of breeding behavior. We plan to coordinate our summer 2000 sampling with that of Dr. Castellini. All procedures will be approved by the ASLC scientific committee and conducted as required by the IACUC (Institutional Animal Care and Use Committee) of the University of Alaska and ASLC.

This project will complete the sampling program in the next feeding trial beginning in May 2000. We do not anticipate the need for ASLC bench space or office space in FY 01. We do include funds for one trip for the PI and graduate student to the ASLC for finalization of sampling and any necessary clean up. The analytical work will be undertaken at UAF and the remainder of the project duration will be in Final Report preparation and the submission of manuscripts detailing our findings. We have already presented initial findings at the EVOS meeting in January 2000 and anticipate submission of more complete findings at the next EVOS meeting in 2001.

Sources of Essential Amino Acids in the Diets of Harbor Seals

We are fortunate in having a wide suite of potential prey samples derived from the Prince William Sound region and offshore Gulf of Alaska from past EVOS studies. Additional samples are also available from the Bering Sea region to allow geographic contrast in isotope ratios. The APEX program supported by EVOS will be a source of samples, as will other opportunistic cruises in the spill and control areas. Herring, sand lance, pollock and capelin will be special targets, given their importance in the food chains of Prince William Sound.

Ms. Liying Zhao is the Ph.D. candidate is undertaking the experimentation on this project. Ms. Zhao has an exceptionally strong background in chemistry and has been undertaking the daunting task of developing the methodologies needed to isolate sufficient individual amino acids to provide an isotope ratio for each of the approximately ten essential amino acids. The task has required a triple approach – isolation of derivatized amino acids, isolation of free underivatized amino acids and an integrated GC-MS procedure that would eliminate the need for HPLC processing. To date, the first procedure offers the best results and cleanest separations but complicates the calculations of isotope ratios through the addition of the derivatizing carbon. This requires back calculation of the apparent isotope ratio of the free amino acid. We hope to

circumvent this obstacle in the next few months through the purchase of a larger semi-preparative scale HPLC with much larger capacity and an ion-exchange column. The costs for this instrumentation are being obtained from other sources.

The biochemical expertise and advisement of Ms Zhao are from her graduate committee of which the PI is the chair. Other members include:
Dr. Michael Castellini, Professor of Marine Science, has his background in biochemistry and is currently involved in studies of marine mammal nutrition at the ASLC.
Dr. Larry Duffy, Professor of Biochemistry and Chemistry, is the current Head of the Chemistry and Biochemistry Program.
Dr. Susan Henrichs, Professor of Marine Science, is a chemist specializing in the microbial biochemistry of amino acids in marine environments.
Dr. Bruce Finney, Professor of Marine Science is experienced with the environmental aspects of ocean chemistry and stable isotope methodology.

The above committee is assisting in experimental design and review of protocols as well as assist with scoping.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

M. Castellini is concurrently working on Project 00341 for related work on blood hormones and food assimilation efficiency studies at the Alaska SeaLife Center. This project will be completely coordinated with his work to optimize sampling and mutual assistance.

SCHEDULE

A. Measurable Project Tasks for FY 01 (October 1, 2000–September 30, 2001) and
B. Project Milestones and Endpoints

FY 01

October - February:	Continue amino acid analyses on samples acquired from final feeding trials, summer 2000. These will constitute reverse labeling with phenylalanine and valine to study transamination efficiencies of essential amino acids.
March - July:	Continue analytical work, prepare prey samples for analysis. Write manuscripts, outline Final Report.
August–September:	Prepare Final Report, submit manuscripts, clean up data gaps, outline needs for future work.

C. Completion Date

This project will be completed by September 2001. Manuscript preparation and submissions may continue past the nominal completion date.

PUBLICATIONS AND REPORTS

Results of this project will be made available via the following:

Annual Reports: These reports will detail progress and preliminary findings and notable achievements. The annual report due April 2000 (18-month progress) is submitted with this proposal. The next report will be the Final Report as scheduled below.

Final Report: A Final Report will be provided. Technical results in this report will be shared with EVOS collaborators and assistance provided as opportune during the experiments. Preliminary exchange of findings will be conducted with EVOS investigators and the scientific community via professional meetings and informal communications.

Peer-reviewed publications: Over the course of this study peer-reviewed publications will be generated for the open literature based on the scientific findings. These publications will be generated by the PI and graduate students as first author publications when the primary focus is on the findings produced by the isotopic techniques or as second author publications when the isotope work is a minor part of other scientific results resulting from feeding experiments conducted by colleagues.

Papers at scientific society meetings: We request support for travel to appropriate scientific meetings for dissemination of results and interaction with colleagues. It is anticipated that the PI and a graduate student will attend the Society for Marine Mammalogy and/or the American Society for Limnology and Oceanography meetings.

Public lectures: Interaction with the public will arise through formal and informal presentation of results as part of ongoing public participation in the work at ASLC. Synthesis meetings designed to explain the findings will be presented at meetings coordinated by ASLC or EVOS and open to the public. Informal presentation of results will occur through interaction with interested members of the public, press and scientific community. Classroom instruction will also involve integration of findings into the presentation of educational material.

PROFESSIONAL CONFERENCES

The results of this project will be communicated at appropriate meetings. The biennial meeting of the Society for Marine Mammalogy or the American Society for Limnology and Oceanography (ASLO) is typical for this type of presentation, as are specific workshops and meetings emphasizing application of isotope techniques to biological problems. The next opportunity will be the annual meeting of ASLO or ad hoc meeting on marine mammals in 2001.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Resources and Services – We have been fortunate to have full coordination and assistance of the ASLC staff and Dr. Michael Castellini for the animal handling requirements of this project. The infusions of amino acids, coordination with known diets and sample handling have been very efficient and helpful. This has allowed full time effort on the difficult and complex analytical aspects at UAF and assured high quality samples for our work. The final label infusions, feeding, and blood collection will occur in FY00 (summer 2000) and we will spend the

remaining program resources on completion of the analytical work and publication of results. No ASLC bench or office space will be needed in FY01.

PROPOSED PRINCIPAL INVESTIGATOR

Donald M. Schell
Institute of Marine Science
School of Fisheries and Ocean Sciences
University of Alaska Fairbanks
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Phone: (907) 474-7115
Fax: (907) 474-7204
E-mail: schell@ims.alaska.edu

PRINCIPAL INVESTIGATOR

D. M. Schell has been involved in stable isotope studies for over 25 years. His research has included natural abundance tracer studies and enrichment experiments. His work on bowhead whales and geographic gradients in stable isotope ratios has been published and extended to the assessment of ecosystem carrying capacity in the Bering Sea and to the assessment of trophic dynamics and feeding of harbor seals in the EVOS region.

Dr. Schell oversees the Stable Isotope Ratio Mass Spectrometry Facility on the UAF campus. This consists of three working instruments, which are dedicated to specific elements, as demand requires. A Europa automated continuous flow system will be used for most samples but back-up analytical capability is available. A new HPLC is being ordered from other sources that have the ability to handle separations of larger quantities of amino acids and will be available for this project. As PI, Schell will oversee the Quality Assurance/Quality Control aspects of this project. Protocols for sampling for mass spectrometry have been established and working standards are cross-calibrated with other nationally recognized laboratories.

OTHER KEY PERSONNEL

Machine operations are the responsibility of Norma Haubenstock, mass spectrometry technician. She is well trained and has more than 11 years experience with mass spectrometers. She will oversee laboratory operations, assist in sample preparation, and archive all isotope data. Ph.D. student Liying Zhao is responsible for the amino acid identification and separation, sample preparation for mass spectrometry and for synthesis of data in cooperation with the PI.

LITERATURE CITED

Best, P.B. and D. M. Schell 1996. Stable isotopes in southern right whale (*Eubalaena australis*) baleen as indicators of seasonal movements, feeding and growth. *Mar. Biol.* 124:483-494

Dunton, K.H., S.M. Saupe, A.N. Golikov, D.M. Schell and S.V. Schonberg. 1991. Trophic relationships and isotopic gradients among arctic and subarctic marine fauna. Mar. Ecol. Prog. Ser. 56:89–97.

Hare, P.E. M.L. Fogel, T.W. Stafford, A.D. Mitchell and T.C. Hoering. 1991. The isotopic composition of carbon and nitrogen in the individual amino acids isolated from modern and fossil proteins. J. Archaeological Science 18:277–292.

Hobson, K.A. and H. Welch. 1992. Determination of trophic relationships within a high arctic marine food web using $\delta^{13}C$ and $\delta^{15}N$ analysis. Mar. Ecol. Prog. Ser. 84:9–18.

Michener, R.H. and D.M. Schell. 1994. The use of stable isotopes in tracing marine aquatic food webs. In: R. Michener and K. Ljatha (eds.). *Stable Isotopes in Ecology and Environmental Research*, p. 138–157. Blackwell Scientific, Cambridge.

Saupe, S.M., D.M. Schell and W.B. Griffiths. 1989. Carbon-isotope ratio gradients in western arctic zooplankton. Mar. Biol. 103:427–432.

Schell, D.M., S.M. Saupe and N. Haubenstock. 1989. Bowhead whale (*Balaena mysticetus*) growth and feeding as estimated by techniques. Mar. Biol. 103: 433–443.

Vinette, K.A. 1992. Carbon and nitrogen isotope ratios in bowhead whales and their zooplankton prey as indicators of feeding strategy and environmental change. M.S. Thesis, University of Alaska Fairbanks. 147 p.

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001						
Personnel		$0.0						
Travel		$0.0						
Contractual		$86.8						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$86.8			Estimated	Estimated		
General Administration		$6.1						
Project Total		$92.9						
Full-time Equivalents (FTE)		1.4						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY01

Prepared:

Project Number: 01371
Project Title: Effects of Harbor Seal Metabolism on Stable Isotope Ratio Tracers
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001	[redacted]
Personnel		$53.1	
Travel		$4.9	
Contractual		$9.0	
Commodities		$2.4	
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS
Subtotal		$69.4	Estimated / Estimated
Indirect		$17.4	
Project Total		$86.8	
Full-time Equivalents (FTE)		1.4	[redacted]
			Dollar amounts are shown in thousands of dollars.
Other Resources			

Comments:

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

Student personnel costs include resident tuition of $3,006 per year.

FY01

Prepared:

Project Number: 01371
Project Title: Effects of Harbor Seal Metabolism on Stable Isotope Ratio Tracers
Name: Donald M. Schell

FORM 4A
Non-Trustee
SUMMARY

2001 EXXON VALDEZ TR...E COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs: Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 2000
Donald M. Schell (PI, Director, IMS; Professor)			1.7	11.8		20.1
Norma Haubenstock, Technician			3.0	5.2		15.6
Ph.D. Student (TBA)			12.0	1.5		17.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	16.7	18.5	0.0	
					Personnel Total	$53.1

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 2000
Fairbanks to national meeting	1.2	1	8	0.1	2.3
Fairbanks to Anchorage (EVOS meeting)	0.3	1	5	0.1	1.0
Fairbanks to Seward	0.8	2	7	0.1	1.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.9

FY01

Prepared:

Project Number: 01371
Project Title: Effects of Harbor Seal Metabolism on Stable Isotope Ratio Tracers
Name: Donald M. Schell

FORM 4B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed
Description	FY 2000
Mass spectrometry (400 samples @ $18/sample)	7.2
Final report preparation, page charges	1.6
Communications, photocopying	0.2
Contractual Total	$9.0

Commodities Costs:	Proposed
Description	FY 2000
HPLC column, chemicals, expendables	2.2
Project supplies (computer software)	0.2
Commodities Total	$2.4

FY01

Prepared:

Project Number: 01371
Project Title: Effects of Harbor Seal Metabolism on Stable Isotope Ratio Tracers
Name: Donald M. Schell

FORM 4B
Contractual & Commodities
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

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

Existing Equipment Usage:	Number	
Description	of Units	

FY01

Prepared:

Project Number: 01371
Project Title: Effects of Harbor Seal Metabolism on Stable Isotope Ratio Tracers
Name: Donald M. Schell

FORM 4B
Equipment
DETAIL

01372

Steller Sea Lion Monoriting

Project Number:	01372
Restoration Category:	Enhance/Replace Subsistence Resources
Proposer:	Native Village of Eyak
Lead Trustee Agency:	Native Village of Eyak, a Federally Recognized Tribal Government.
Cooperating Agencies:	DOI, ADFG, NMFS, & CRRC.
Duration:	1st year of a five year project.
Cost FY 01:	$250,000
Cost FY 02:	$250,000
Cost FY 03:	$250,000
Cost FY 04:	$250,000
Cost FY 05:	$250,000
Geographic area:	Copper River, Prince William Sound.
Injured Resource/Service	Subsistence

Abstract:

Steller Sea Lions are on the decline and have been placed on the endangered list by NMFS. If this trend continues, subsistence fishing for salmon, herring and other marine life will be curtailed. Some traditional areas may be closed to all fishing & hunting. We need to monitor the interaction between the Steller Sea Lions and the fishing fleets. This proposal would fund this interaction.

NATIVE VILLAGE OF EYAK
P.O. Box 1388, Cordova, Alaska 99574
Tel 907-424-7738 Fax 907-424-7739

April 14, 2000

Molly McCammon
Executive Director
Exxon Valdez Oil Spill Trustees Council
645 G Street, Suite 401
Anchorage, Alaska 99501-3451

Dear Molly

Enclosed is a restoration proposal to monitor Western Stellar Sea Lions in the Prince William Sound/Copper River area. As the Western Stellar Sea Lions have been placed on the endangered list by NMFS. The dividing line between the Western and Eastern Steller Sea Lions is Cape Suckling. The eastern boundry of Area E Salmon district is Cape Suckling. It is critical that we find out the reason for their demise. Should the decline in the Sea Lion numbers continue, the subsistence harvest of salmon, herring and other marine life will be curtailed.

We have submitted this proposal in past. This problem is becoming more critical now then it has ever been.

We are requesting technical assistance from EVOS for this proposal.

Sincerely yours

Bob Henrichs
President
Native Village of Eyak
Traditional Council

PROJECT TITLE: Kachemak Bay Citizen Researcher: Development of a Community-Based Marine Monitoring Program

Project Number:	01384
Restoration Category:	Ecosystem Synthesis, Development of Community-Based Marine Monitoring
Proposer:	ADFG
Lead Trustee	ADFG
Cooperating Agencies:	
Alaska SeaLife Center:	No
Duration:	First-year, 2-Year Project
Cost FY 01:	$110.9 First Year
Cost FY 02:	$ 58.0 Second Year
Geographic Area:	Kachemak Bay, Southern Kenai Peninsula, and Lower Cook Inlet
Injured Resource/Service:	Kachemak Bay includes all injured resources (except cutthroat trout, Dolly Varden, and AB Orca pod) and all the lost or reduced services. While the pilot project is in Kachemak Bay its applicability is to the entire EVOS area.

ABSTRACT

The Kachemak Bay National Estuarine Research Reserve (KBNERR) will develop a prototype community-based citizen-monitoring program. NERR will partner with the Center for Alaska Coastal Studies to pilot two monitoring projects, evaluate, and disseminate the multi-level Citizen Researcher protocol and additional research education strategies to the EVOS region. Products will include: 1) *a Tools Manual for Research Education* providing low and moderate cost strategies designed to link research and monitoring and their results with the community, (intended for researchers and educators) and 2) a Train-the-Trainers manual and trainings for community educators community within the spill region.

INTRODUCTION

As requested in the EVOS *Invitation for Restoration Proposals*, The Kachemak Bay National Estuarine Research Reserve (KBNERR) plans to develop a prototype community-based citizen-monitoring program. It will be structured as an integrated multi-level community-based effort designed to monitor biological and physical conditions of the marine environment. The prototype program will be organized and developed around nine key concepts:

1. Suitable for application throughout the oil spill-affected area.
2. Engaging citizens in the collection of "real data" with scientific significance and, that addresses scientific questions of importance to the community.
3. Linking data collection with the transmission of knowledge and understanding to participants about the reasons behind the research, the scientific process that requires the data, and an understanding of the ecosystem(s) studied.
4. Designed for participation at different skill, knowledge, and interest levels with a process to participate and proceed to more expert levels.
5. Providing for data quality assurance and quality control (QA-QC), with methods to manage and analyze the data.
6. A reciprocal program – citizens who collect data must have opportunities to receive analyzed and synthesized data.
7. Having an efficient means for expanding the network of participants.
8. Community ownership developed through meaningful participation and input.
9. Cost-effectiveness.

The first three concepts link this proposed project to the Kachemak Bay Ecological Characterization (KBEC/278), which was partially funded by EVOS restoration funds. KBEC was developed as a means to disseminate and extend the integration and synthesis of what has been and will be learned from restoration projects.

Community-based citizen monitoring, if planned and implemented around these concepts, has the potential for benefiting EVOS-related scientific endeavors through additional data collection. It also will benefit the citizens and society as a whole through increased understanding and informed participation in decision-making about the management of natural resources. Not only does this project meets EVOS' interest in developing a conceptual prototype of community-

based marine monitoring for its restoration components, but parts of the project will provide a foundation for transition to the Gulf Ecological Monitoring Program.

The KBNERR will develop a conceptual prototype program and pilot it for Kachemak Bay by:

1. Surveying research programs that have as an integral component, the task to "translate" research and results to citizens and local decision-makers. KBNERR will focus on, but not limit itself to, citizen monitoring programs associated with large-scale or long-term research programs.
2. Compiling a draft *Tools Manual for Research Education (Tools Manual)*, that outlines the conceptual prototype and other successful education "translation' strategies based on survey results;
3. Refining the draft *Tools Manual* by:
    a. Implementing a pilot research education assessment project for Kachemak Bay to identify the linkages between on-going research efforts in Kachemak Bay/ lower Cook Inlet and current citizen monitoring efforts. The *Tools Manual* will outline how to determine significant scientific information needs that could feasibly be addressed with citizen observations and data collection.
    b. Partnering with the Center for Alaskan Coastal Studies (a community-based educational nonprofit organization) to pilot the use of the manual in the design and implementation of two pilot "Citizen Researcher" monitoring projects.

The assessment (#3a above) will focus on research and monitoring activities related to the EVOS restoration effort. We will also consider, however, the results of the research summary included in KBEC and the research needs assessment conducted during the establishment of the KBNERR. In addition, we will incorporate other informational needs identified as significant to regional research scientists, communities, resource users, decision-makers, and citizens that are concerned with issues related to management of public resources. The results of the assessment and refined *Tools Manual* will also be applicable to the Gulf Ecological Monitoring (GEM) transition. The process for assessing research needs will be applicable throughout the oil spill-affected area..

The pilot projects (#3b) will be related to the EVOS restoration effort and/or long-term monitoring projects to be conducted by the KBNERR. These Citizen Researcher projects will entail:

1. developing data collection protocols,
2. training and ecological education of Citizen Researchers,
3. designing and implementing a data management/Geographic Information System (GIS) compatible with KBEC and Cook Inlet Information Management Monitoring System (CIIMMS), and
4. developing methods for communicating results and extending citizen learning beyond data collection.

The partnership of the KBNERR and community-based CACS combines the resources of two organizations with dual missions of research and education. The KBNERR can draw on its professional scientific research and education staff, the experience of the other 25 NERRs nationwide within NOAA's Estuarine Research Division (ERD), and the resources of its NOAA/Alaska Department of Fish and Game partnership. The CACS can draw upon 18 years of experience with science-based education programs and volunteer training and coordination in Kachemak Bay communities.

NEED FOR THE PROJECT:

A. Statement of Problem:

The long-term success of any environmental monitoring and research program requires public education and support. The challenge for monitoring and research programs is to engender public appreciation for research needs, techniques, and results through means beyond publishing in scholarly journals and presenting at scientific conferences. In 1996 the EVOS Trustee Council Public Advisory Group conducted a review of the Council's communication/information efforts. The review demonstrated that Council efforts have been diverse and innovative. However, a

coordinated assessment of strategies that have been employed nationally or internationally to increase public involvement and support for research and monitoring has not been done and is needed. Our preliminary survey of national and international programs that seek to couple research and education provides evidence that an effective method to accomplish understanding and support for long-term research and monitoring is to somehow involve local communities in the studies. Through their personal involvement, citizens can gain a sensitivity to the needs for the specific research or monitoring efforts, understanding of the data collection protocol, and comprehension of the research processes.

The Invitation to Submit recognizes the benefits of integration and synthesis of project results for the public to view the effects of the oil spill and the long-term restoration and management of injured resources and services in broad, ecological contexts. This benefit can only be realized, however, through sustained and effective "translation" and dissemination of the integrated and synthesized information to the public in a manner that makes sense to them. In addition, involving citizens in community-based monitoring of estuarine/marine systems, if done in a manner that integrates learning about the systems and their processes with the data collection, can be an effective means for disseminating the results of restoration.

The concepts around which the prototype-monitoring program will be organized emerge from our preliminary survey of research-education programs. In addition, several of the concepts encompass the results of decades of scrutiny into what makes science education effective. This research culminated in extensive science education reform standards at the national level. Standards for excellence in education were adopted in 1995 by the National Research Council for "lifelong learners" (National Academy of Sciences 1996) and have been adopted by the Alaska State Board of Education as standards for science education in Alaska (ADOE 1996). Standards relevant to citizen monitoring programs emphasize "hands-on" learning, learner-centered approaches (in contrast to expert or instructor-centered), learning concepts rather than facts, and learning science and scientific process skills and "attitudes of mind" by doing science. Shirley Malcolm, Head of the Directorate for Education and Human Resources for the American Association for the Advancement of Science (AAAS) summed up standards relevant to the benefits of citizen monitoring succinctly:

> "The fundamental idea is that one only comes to understand the nature of science by engaging in the doing of science . . . and this can only be achieved by

> partnerships of scientists with learners and with those whose behaviors and decisions affect learners. . . What does that look like? Yes, it involves real questions. Yes, it involves authentic experiences. And yes, it involves real data. . . [and] where . . . the community has defined what is important, what it is desirable to know, what it is important to learn"
> (TERC and the Concord Consortium 1997).

Scientific research, public information, and public participation have been key activities that have contributed to progress towards and successful Exxon Valdez oil spill restoration. Eleven years after the spill, EVOS studies have produced an abundance of new scientific information and understanding about marine ecosystem processes. The combined oversight of the EVOS Trustee Council and staff, the Public Advisory Group, community facilitators, and the peer review process have worked to ensure valid and integrated research and restoration efforts targeted at spill-affected species and resources. EVOS public information efforts and public participation have been innovative and varied. Information on past efforts was organized into a useful for in-house use and public awareness. What is needed, however, is a tool for planning and evaluating the potential effectiveness of specific strategies for specific types of research and the translation of research results for lay audiences. This must be in a format useful to community educators, on the one hand, and research scientists, on the other, with a mutual interest in the effective transfer of scientific and traditional or local knowledge. The proposed project would develop the prototype for effectively linking research, education, and public information within the communities in the oil spill-affected area.

The EVOS-supported Youth Area Watch program and involvement of subsistence hunters in biosampling of harvested harbor seals is an example of effective integration of research, K-12 education, and community involvement. The concerted effort of the Council to encourage investigators to incorporate and involve traditional ecological knowledge in the development and implementation of restoration projects is an important element in the two-way communication between "western science" and traditional approaches to knowledge about the environment. What has **not** yet occurred, however, is:

- a coordinated involvement of educators in the process of determining community needs and interests for information,

- effective strategies of how to disseminate scientific and technical information to lay audiences in the context of citizen participation in the scientific process,
- the design of community-based monitoring programs that benefit communities and citizens through increased knowledge and understanding in addition to the data collected,
- integrated community participation in research and monitoring linked to local "professional" scientific studies.

Several community-based citizen monitoring projects exist within the spill area which have been supported by EVOS. Unfortunately, existing projects are generally so narrow or so broad in focus that the likelihood that these specific types of monitoring efforts could provide both meaningful citizen participation and meaningful scientific results throughout the ecologically and culturally diverse spill area is unlikely. The Youth Area Watch harbor seal biosampling project is an example of a project that although exceptionally significant, is possible and meaningful only in communities where subsistence hunting of the seals is an important community activity. Watershed-based water quality sampling, on the other hand, is an example of a type of environmental monitoring with broad applicability. Water quality data collection can occur in all watersheds, and be accomplished feasibly and cost-effectively by trained volunteers. But the types of water quality data that can be gathered by citizen monitors are not easily linked with EVOS research needs for data, particularly in the marine environment. This project would provide a process and a support mechanism for communities to better identify and implement monitoring programs that are meaningful to each community. At the same time, their efforts will produce meaningful scientific results that would complement professional scientific efforts. It will also pilot the process with an intertidal monitoring project, a focus that would be applicable in many, if not all, of the oil spill-affected communities and which would generate information about change in the marine environment.

B. Rationale/Link to Restoration

It is important to provide citizen monitoring in Kachemak Bay in order to continue observing and studying spill-affected species and resources. Some of these species have been designated as recovering, some as not recovering, and others whom the recovery status is unknown. EVOS study sites in Kachemak Bay compare population dynamics and conditions of "recovering" species (e.g., common murre, marbled and Kittzlitt's murrelets) and "not recovering species"

(e.g., pigeon guillemot) with population dynamics of non- spill-affected areas. Kachemak Bay provides seasonal habitat for harlequin ducks that breed in Prince William Sound--the species classified as "not recovering." Thus, citizen monitoring could contribute to knowledge about the status and/or natural dynamics of these species as well as other "recovering" resources (i.e., sea otter, clams, mussels, and intertidal and subtidal communities) and resources that are "not recovering" (i.e., common loon, cormorants, harbor seal, orca).

Port Graham and Nanwalek have designed a citizen monitoring project to use caged bivalves as a bio-assay tool for water quality. They suggested their proposed project could be nested in KBNERR's studies and be a part of the Citizen Researcher project (Personal communication, Paul McCollum, April 9, 2000). Although citizens may not undertake complicated lab tests, collection and monitoring of muscle growth and qualitative observations can be made with sufficient training.

The intertidal monitoring pilot project we proposed is particularly relevant to the broad ecological context of recovery because it will be nested within a KBNERR research project. This research is designed to detect change in benthic and subtidal habitats and biological communities at multi-spatial and multi-temporal scales. The KBNERR project's objective is to develop a model that relates physical conditions to the biological communities that would be expected under natural environmental dynamics.

C. Location

The Citizen Researcher project will be undertaken in Kachemak Bay in FY01 and expanded to Prince William Sound in FY02. The communities of Homer, Seldovia, Nanwalek, Port Graham, Seward, and Cordova will be directly benefited by the project, however the products of the project will have applicability throughout the spill area.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Kachemak Bay communities are in a unique position relative to other communities in the spill-affected areas in terms of capability and cooperation of environmental educators. These communities already have several established educational organizations that could support and benefit from citizen monitoring and a cadre of natural history-oriented volunteers and staff to draw upon to implement the pilot projects.

Designation of the entire bay as a National Estuarine Research Reserve, with dual emphasis on encouraging estuarine research and education, recently catalyzed 15 organizations and entities with involvement in environmental education in Kachemak Bay to organize themselves into the Kachemak Bay Environmental Education Alliance (KBEEA) in March, 2000. The group was comprised of representatives from Homer, Seldovia, Nanwalek, and Port Graham, and included Lillian Elvsaas, EVOS Community Facilitator for Seldovia. One of the highest priorities the KBEEA identified was the development of additional citizen monitoring. Expanding the Citizen Researcher project to multiple partners and monitoring projects are logical next steps following developing the prototype. We will coordinate the pilot with Cook Inlet Keeper (CIK). Developing an integrated monitoring program with CIK and other KBEEA partners, particularly Seldovia, Port Graham and Nanwalek, are logical next steps for a subsequent proposal for the EVOS / GEM transition period.

Cook Inlet Keepers (CIK) have managed a highly regarded citizen-monitoring program in Kachemak Bay for four years. They are developing an integrated Cook Inlet program using EPA accepted water chemistry protocols, and a QA-QC management plan; they have expressed desires for KBNERR to take-over their citizen monitoring program in Kachemak Bay. CIK are interested in aligning their citizen-monitoring with KBNERR's ongoing research and wish to continue to "grow and strengthen these [volunteer monitoring] efforts" beyond water chemistry, "by coordinating with the KBNERR education and monitoring research projects" (Marla McPherson, CIK, April 7, 2000). In contrast to the current CIK emphasis on water quality of fresh water habitats, our prototype program will have a stronger focus on estuarine/marine biological resources and the physical and chemical factors related to their habitat conditions. Wherever feasible, however, the planning and pilot projects of the Citizen Researcher project will be coordinated with on-going water quality monitoring in estuarine waters being conducted by CIK. We will accomplish this by coordinating joint marine sampling sites and volunteer data collection, cross-training of volunteers, and data sharing.

In 1999, Environmental Specialists in the Villages of Port Graham and Nanwalek became certified instructors for Global Learning and Observations to Benefit the Environment (GLOBE) in a workshop taught by Dr. Foster, KBNERR's Education Coordinator. Another logical next step following development of the prototype program would be to integrate GLOBE monitoring in these communities. In addition, we would include the research being conducted by the Fisheries Biologist employed by the Villages of Port Graham and Nanwalek's Fisheries Biology into the Citizen Researcher Program.

In FY 2001, the KBNERR will complete the Kachemak Bay Ecological Characterization (KBEC), a source of synthesized, integrated information about the area's marine and terrestrial ecology that will be unparalleled for any other estuary or watershed in Alaska. KBEC provides the foundation for identifying potential linkages between research, education, and citizen monitoring (#2). The KBEC incorporates Traditional Ecological Knowledge from extensive interviews of Port Graham, Nanwalek, and Seldovia Village members of Ron Staneck of ADF&G and local knowledge from extensive interviews of long-time residents in the Homer area by anthropologist Janet Klein.

The Natural Resources Conservation Service (NRCS) has a "citizen monitoring" program in Nanwalek and Port Graham. It enlists the help of the Tribal Natural Resource Specialists, Edgar Otis and Nancy Yeaton, to survey snow and water conditions within the watershed. This project is being nested into the Port Graham / Nanwalek Watershed Council's Wetland natural resource assessment project. A logical next step of Citizen Researcher will be to collaborate with these fine projects.

PROJECT DESIGN

A. Objectives

1. Develop a conceptual prototype program for community-based monitoring and other effective methods for translating research to citizens and local decision-makers based on nine criteria:
   A. Suitable for application throughout the oil spill-affected area

B. Engaging citizens in the collection of "real data" with scientific significance and that addresses scientific questions of importance to the community.

C. Linking data collection with the transmission of knowledge and understanding to participants about the reasons behind the research, the scientific process that requires the data, and an understanding of the ecosystem studied.

D. Designing for participation at different skill, knowledge, and interest levels with a process to participate and proceed to more expert levels.

E. Providing for data quality assurance and quality control (QA-QC), with methods to manage and analyze the data.

F. A reciprocal program – citizens who collect data must have opportunities to receive analyzed and synthesized data.

G. Having an efficient means for expanding the network of participants.

H. Community ownership developed through meaningful participation and input.

I. Cost-effectiveness.

2. Pilot the prototype program with a research education assessment for Kachemak Bay and two "Citizen Researcher" projects: 1) Kachemak Bay Intertidal Monitoring Project (K-Bay IMP) and 2) the Kachemak Bay Beach and Bay Observer Project (K-Bay BBOP).

3. Disseminate the program and the results of the pilot projects in the form of a *Tools Manual for Research Education* to scientists and research program managers, educators and education program managers, natural resource managers, community decision-makers, and the general public.

4. Develop and distribute a "Train-the Trainers" for manual community educators.

5. Train community educators in communities in Kachemak Bay (Homer, Seldovia, , Nanwalek, Port Graham), Seward (Sea Life Center), and Prince William Sound (Cordova -- PWS Science Center).

B. Methods

1. Develop the conceptual prototype program for community-based monitoring and other effective strategies for translating research to citizens and local decision-makers

After an extensive Internet search, we will use a mail/email questionnaire with telephone follow-up to survey large-scale ecosystem-based research programs (at least watershed-level in scale). The purpose of the survey will be to identify effective education and outreach strategies. We will focus on citizen monitoring programs and on the seven criteria listed for this objective. (Examples of the numerous programs to be surveyed include: the 25 NOAA/state National Estuarine Research Reserves, the 26 EPA-sponsored National Estuary Projects, NOAA National Marine Sanctuaries, Monterey Bay Research Institute, NASA's Earth Systems Observation Program, Arctic Research Consortium of the U.S.).

We will use the results of the survey to develop a draft *Tools Manual for Research Education*. This manual will include the following components:

- Outline of the process for assessing community research needs and opportunities for involvement in professional research being conducted in or near the community.
- How to design a community-based monitoring or research program that has effective education and outreach components.
- How to design and support community-based monitoring projects to address specific data needs in hierarchical levels, based on "novice," "experienced," "advanced,"and "expert," levels of Citizen Researcher in relation to their skills, knowledge, time available for participation, and commitment.
- How to design and support appropriate levels of training and background information for Citizen Researchers in relation to the research design and methods being employed, the desired precision and reliability of data being collected, and learning objectives in relation to the scientific process and/or community issue.
- How to identify appropriate audiences to receive the results of research.
- How to match audiences with appropriate low and moderate-cost education for effectively "translating" research results
- How to link citizen-based monitoring with a GIS, (using KBEC as the example) to assess possible threats to the marine effort as the basis for selection of future monitoring efforts and to identify opportunities and needs for community planning. NOTE: This above aspect will coordinate well with the "Non Point Source Education for Municipal Officials" program (NEMO). NEMO is a NOAA/ERD and EPA (319) funded education programs for land use decision makers that links land use to water quality using GIS.

2. Piloting the prototype program with a research education assessment for Kachemak Bay

First, we will assess potential research education needs for Kachemak Bay by compiling and integrating the results of:

- a review of data collection needs by on-going EVOS projects or necessary to extend EVOS research / monitoring projects,
- a review of on-going and planned research in Kachemak Bay/lower Cook Inlet compiled as a component of the KBEC,
- research and monitoring needs identified for KBNERR by Kachemak Bay communities during public involvement in development of the KBNERR Management Plan and by the needs and priorities of the NERR system as a whole

Second, we will survey current citizen-based monitoring efforts for Kachemak Bay to identify potential linkages. Finally, we will compile a list of significant scientific information needs that could feasibly be addressed by citizen observations and data collection.

3. Piloting the prototype program with "Citizen Researcher" projects:

Each pilot project will have four levels of potential citizen participation, all of which will be linked in some way to a professional scientist involved in a research project. Citizen monitors will have opportunities at all levels to extend their knowledge and understanding of the scientific process and the Kachemak Bay and Northern Gulf of Alaska ecosystem.

Novice Level The Novice Level assumes that many people can make useful observations provided no equipment is needed, enough information is provided to reduce the probability of incorrect information, and the commitment of time is low and incidental to engaging in other activity (e.g., taking a walk on the beach). The educational effort is one that requires no direct instruction (e.g., mass-media approach of posters and repetitious use of local media), but the actual skill level of the observer and thus, the accuracy of the data collected are unknown for many participants.

Training Level the Training Level assumes that trained participants can collect data and observations in a structured way with a longer and scheduled commitment of time for training

and data collection. The data collected will be qualitative or, if quantitative, will not be collected in a way that permits rigorous statistical analysis, but will provide a basis for detecting broad trend and change. Instruction and training will occur in group learning situations.

Advanced Level. The Advanced Level assumes in-depth training, quality control of data collection procedures, and quality assurance for validity of data. This level of data management and quality control/quality assurance methods for data corresponds to the CIK citizen water quality monitoring program. Instruction and training would occur in small group or one-on-one learning situations. Advanced Citizen Researchers would be involved in training of other citizen monitors.

Expert Level the KBEEA identified a high priority for researcher mentor opportunities for one-on-one partnerships between scientists and students at the high school, college, or graduate school level. This level, which requires a larger commitment of time by the professional researcher, may not be possible for all programs. Student-scientist partnerships would be developed with students as full participants in research teams. The NRCS program in Port Graham and Nanwalek is an example of this level.

Kachemak Bay Intertidal Monitoring Project *(K-Bay IMP)*

Intertidal monitoring has broad applicability throughout the spill area. It can provide the basis to document natural ecological dynamics and to detect negative impacts by human beach users such as trampling and disturbance of intertidal habitats and organisms by recreational and educational beach users. It can also provide the means to monitor whether measures implemented to reduce negative impacts are effective.. The overuse of several beaches for recreation and intertidal education was identified as an important stewardship issue for Kachemak Bay by the KBEAA in February, 2000. This project would involve a re-design and extension of on-going CACS research and monitoring projects to both address the overuse issue and to provide citizen data collection that would complement a KBNERR long-term monitoring and research project.

CACS currently conducts beach and intertidal zone surveys at two levels of intensity. Dr. Carl Schoch, the KBNERR Science Coordinator, will assist CACS staff in revising data collection protocols into a three-level survey. This process will provide the best continuity with the data already collected. It will also provide predictable levels of scientific accuracy that can be linked

at the more intensive sampling levels to modeling and mapping efforts to correlate physical processes and biological communities. Then, we can connect the mapping/modeling efforts and citizen-based efforts to better detect changes and relate them to human impacts.

Novice Level: CACS currently has no organized program to collect intermittent or casual observations related to intertidal species distribution or abundance, sightings of exotic species (e.g., green crab), or timing of significant biological events (e.g., barnacle set, onset of spring phytoplankton bloom, cold-induced mortality of mussel beds) for Kachemak Bay. The novice level of this pilot project would consist of widely-distributed information on desired sightings (e.g., posters) and a method (e.g., place to log in sightings) to collect observations from users at Bishop's Beach, the Homer Spit beaches, and the Outside Beach near Seldovia. Selection of the methods to inform and involve beach users in data collection and extend the program with additional opportunities for education will follow those recommended in the *Tools Manual*. The same types of observations will also be collected by CACS staff and volunteers, with varying levels of expertise, from mid-April through early September at China Poot and Peterson Bays, and requested from Kasitsna Bay Lab researchers.

Training Level: CACS has conducted an annual Coast Walk program along the shoreline of Kachemak Bay 15 times since 1983. The program consists of citizen volunteers using a checklist to collect the same types of observations of wildlife and evidence of human use on 32 defined shoreline segments. Community participation peaked at 250 participants in May, 1989, when detailed observations of occurrence of oil on beaches were made following the Exxon Valdez oil spill. Dr. Schoch would provide guidance for valid data analysis methods for past survey results to detect trends and for revision of the questionnaire to increase its usefulness in detecting trends of interest. As part of the pilot project, we will publicize the results of the trend analysis, in the broader context of integrating and synthesizing EVOS project results, using strategies recommended in the *Tools Manual*. *Coast Walk* is currently conducted in late September. The results of this portion of the overall project will, thus, not available in time for Year 2001 Project Report.

Advanced Level: CACS has been conducting a multi-year study of the effects of trampling in the intertidal zone in China Poot Bay. Their intertidal education programs at this location that involved approximately 600 K-12 Alaska school children and teachers and another 1,000 visitors

in 1999. A portion of the beach has been designated a "no-impact zone" and roped off from use since 1994 Intertidal transect and quadrant data have been collected by college interns and CACS staff trained to identify marine invertebrates and seaweeds in 1998 and 1999 within the "no impact" zone and a control area, using methods developed by the Island County/Washington State University Beach Watchers program for intertidal monitoring of Washington beaches (King et. al. 1997).

The Advanced Level pilot project will consist of a citizen monitoring project in China Poot Bay and on other heavily-used Kachemak Bay beaches using more intensive sampling and protocols developed by Dr. Schoch to validly detect and compare change in intertidal communities over time. CACS staff will train and supervise volunteers in identification of marine invertebrates and seaweeds and in the data collection protocols. The data collected by citizen monitors will also extend and be nested within a long-term multi-scale Shoreline Classification and Landscape Extrapolation (SCALE) mapping and monitoring project that will be conducted by Dr. Schoch for the entire KBNERR shoreline.).

The SCALE methodology has been successfully applied to spatially nested study sites on temperate rocky shores along the exposed U.S. West Coast from Canada to Mexico. It is also applied for the Partnership for Interdisciplinary Studies of the Coastal Ocean (PISCO): A Long Term Ecological Consortium project, and soft sediment habitats in the Puget Sound estuary for the Washington Department of Natural Resources to map and monitor estuarine and coastal marine biological diversity. Dr. Schoch is planning to build on the NOAA National Marine Habitat Classification system and refine their small spatial scale classifications for estuaries and marine shorelines. Citizen monitors can provide long-term monitoring of biodiversity in small-scale intertidal plots thus providing long-term reference sites in which macro-invertebrate and algal indicators, identified by his modeling effort, can be monitored to detect environmental change.

Expert Level: CACS will recruit and train a college intern or Tribal Environmental/Natural Resource Specialist who will participate in the Advanced project and be mentored by Dr. Schoch and Dr Foster.

Kachemak Bay Beach and Bay Observer Project (K-Bay BBOP).

This pilot project will be designed to involve members of a large group of potential observers and educators that is largely untapped by organized citizen monitoring efforts. Similar to the situation for other communities within the spill area, ecotourism and sport fish charter boats cruise Kachemak Bay and lower Cook Inlet on a daily basis during the summer, providing a large number of "eyes and ears." Onboard, some version of local environmental knowledge is usually provided to visitors. Commercial fishermen and Native hunters are another source of local data and Traditional Ecological Knowledge about the distribution and ecology of fish and wildlife. The potential of an organized shipboard observer program for Kachemak Bay and other areas within the spill area has been demonstrated by the efforts of Ginger Strong, deckhand/naturalist working for Rainbow Tours. Ms. Strong travels between the Homer Small Boat Harbor and the CACS dock in Peterson Bay, and from Homer to Seldovia on at least a daily basis from mid-April through early September. She began making humpback whale and orca observations in 1996 and fluke and pectoral fin photos-- the methods used by professional whale researchers to identify individual whales. Her data have been provided to the National Marine Fisheries Lab in Seattle confirming her documenting an increase in the number of individual humpback whales from six in 1998 to 15 in 1999. She also documented the unusual and prolonged use of the bay by three gray whales in 1999, one of which was later found dead in upper Cook Inlet (Strong, unpublished data). No outreach or education program currently exists to extend whale observation methods to observers on other boats. Also needed is a vehicle to provide the extended learning that would link the observations to large-scale and/or long-term ecosystem dynamics (including the long-term effects of the oil spill), and to support incorporation of new ecological knowledge and understanding into shipboard educational programs.

The specifics of the *novice, training, advanced*, and *expert* levels for this project will be developed based on the assessment of data needs. The development of data collection protocols, and means to recruit and train observers will also direct the protocol at each level. The "professional" scientist will be involved to interact and correspond to citizen researchers at all levels, but will be working most directly at the expert (mentor) level.

Both pilot projects will also involve design and implementation of a data management system and interactive education methods. We will use the Internet to communicate with Citizen Researchers at all levels, to disseminate the results to Citizen Researchers, and to extend the

learning. Local citizen participants will meet at Kasitsna Bay Lab on the south side of Kachemak Bay to evaluate the pilot projects. The *Tools Manual* will be refined based on lessons learned during implementation of the pilot projects and the results of evaluations by the participants in the pilot projects. However, because the K-Bay IMP pilot program implementation will continue into FY2002, the final evaluation of pilot of the Training Level for this project will not be completed in FY2001. A supplement to the *Tools Manual for Research Education* will be distributed, if necessary, in FY2002.

4. Disseminating the program and the results of the pilot projects

We will publish and distribute the final *Tools Manual for Research Education* to scientists and research program managers, educators and education program managers, natural resource managers, community decision-makers, and the general public. Funding permitting, we will provide presentations or poster sessions at appropriate annual conferences for educators and scientists.

5. Completing the Evaluation and Train-the-Trainers Program (FY2001)

As noted above, data collection for the Training Level of the intertidal monitoring pilot project cannot be completed until late September. Funding permitting, we will evaluate this portion of the pilot project in FY2002 and write a supplement to the *Tools Manual* if needed, based on the results of the evaluation.

A "Train-the-Trainers" dissemination approach is employed in many education programs (e.g., GLOBE, Project WILD, Project Learning Tree) to multiply the network of trained people who can, in turn, train additional people. Dr. Foster was the co- developer for a Train-the-Trainers manual for the Chugachmiut/Alaska Inter Tribal Council's *Seven Generations: Assessing Village Environmental Issues*. The Train-the-Trainers manual for Citizen Researcher community-based program and project development will be written in FY2002.

Trainings in program and project development based on the *Tools Manual* and the training of citizen participants based on the "Train-the-trainers" manual will be held for community educators in communities in Kachemak Bay (Homer, Seldovia, Nanwalek, Port Graham), Seward, and Prince William Sound (Cordova) in FY2002. The logical partner-institutions for

organizing trainings will be the Prince William Sound Science Center/Oil Spill Recovery Institute in Cordova, and the Sea Life Center in Seward.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

- The Center for Alaskan Coastal Studies will be contracted to review the prototype, to design and to implement the pilot projects.
- The Alaska Maritime National Wildlife Refuge (DOI-FWS) will provide assistance in training Citizen Researchers.
- National Oceanic and Atmospheric Administration (NOAA) will provide information and assistance assessing the citizen monitoring programs in each of the National Estuarine Research Reserves. ERD will also provide a prototype needs assessment tool to be used to design community decision-maker workshops. This will be a valuable component in the *Tools Manual for Research Education.*

SCHEDULE

A. Measurable Project Tasks for FY01 (October 1, 2000 – September 30, 2001)

Date	Task
October 2000:	Develop survey questionnaire for national/international research & monitoring programs.
October – January:	Conduct the survey via mail, email, and telephone follow-up.
January:	Summarize the results of the survey.
January – March:	Write "tools manual" that emphasizes low and medium cost methodologies for effectively involving the community in citizen monitoring and in "translating" research results for various audiences.
February –March:	Organize a conceptual prototype that describes the Citizen Researcher model, process for its development within a community, and successful strategies for translating marine science research results to the community.
January – March:	Assess research and information needs of the community through KBEC and survey.
February – March:	Develop data-collection protocols for novice training, advanced, and

	expert monitoring levels for the pilot projects. Identify high school and/or college mentor students.
January 16 –26:	EVOS Workshop.
January – March:	Design and implement a data management/GIS system compatible with KBEC and CIIMMS. Develop a Citizen Researcher Web Page.
February – March:	Write a volunteer manual.
March – May:	Recruit and train Citizen Researchers.
May – August:	Pilot the Citizen Researcher Program.
May – August:	Collect data or observations.
August:	Enter data into database/GIS.
August:	Analyze data and summarize results
August – September:	Meet with citizen volunteers to review results of data analysis and evaluate program successes and "lessons learned" about the process.
September:	Evaluate the success of the pilot projects in relation to the seven initial concepts.
September:	Compile FY2001 Report.
September:	Present conceptual prototype and distribute manual to KBEEA and Tribal Environmental Specialists/Resource Specialists in Nanwalek and Port Graham.
August – September:	Attend conferences and make presentations to at least two of the following: • National Association of Marine Educators (NAME) • American Association for Advancement of Science/Arctic Division (AAAS) • National Oceanic and Atmospheric Administration Estuarine Reserve Division Annual Meeting (ERD/NERR • American Society of Limnology and Oceanography

September:	Publicize *Tools Manual* availability on the KBNERR, CACS, and Alaska Natural Resources and Outdoor Education Association (ANROE) Web Sites (linked to Citizen Researcher Web).
FY2002	
October -- November 2001:	Complete Citizen Monitoring Program (Fall Monitoring).
November – March:	Evaluate 2001 Citizen Researcher Program.
January – March:	Write a supplement to *Tools Manual* (or revise it as needed).
November – March:	Write Train-the Trainer Manual (for community educators).
April 15:	Annual Report (2000) to EVOS.
March – June:	Citizen Researcher Program Training at Kachemak Bay, Prince William Sound (PWS Science Center), and Seward (Sea Life Center).
July:	Evaluate training program.
August -- September:	Revise Train-the-Trainer as necessary.
September:	Compile Final Report.
April 15:	Annual Report (2001) to EVOS.

6. Project Milestones and Endpoints

February 28, 2001:	Complete draft *Tools Manual* for Research Education."
February 28, 2001:	Complete the assessment of potential research education projects for Kachemak Bay.
	Complete the design, implementation, and evaluation of the success of two pilot Citizen Researcher projects based on the conceptual prototype-monitoring program.
August 31, 2001:	a. K-Bay Intertidal Monitoring Project Novice/Expert Levels.
September 30, 2001:	K-Bay Beach and Bay Observer Project.
August 31, 2001:	Disseminate the prototype program, the

	manual, and the preliminary results of the pilot projects to scientists and community-based educators.
April 15 2002:	Final Report.
FY 2002:	
December 31, 2001:	Complete the evaluation of pilot projects.
March 30, 2002:	Evaluate and complete Train-the-Trainer Manual.
June 30, 2002:	Train community educators.

Completion Date

Year One of the project will be completed by September 30, 2001.

A FY2002 continuance for **one year**, for would support a

- Piloting a fall/Training Level component of the K-Bay Intertidal Monitoring Program,
- Completing evaluating of the program and developing a supplement to the *Tools Manual* (if necessary),
- Writing a Train-the-Trainer Manual
- Providing trainings in Kachemak Bay, Seward, and Prince William Sound (Cordova).
- Evaluating and Revising Train-the-Trainer Manual

PUBLICATIONS AND REPORTS

1. *Tools Manual for Research Education*
2. *Citizen Researcher* Prototype Community Monitoring Program Report
3. *Citizen Researcher* Train-the-Trainer Manual (second year)
4. Peer Review article for Journal of Environmental Education
5. Article for Volunteer Monitor, The National Newsletter of Volunteer Water Quality Monitoring
6. Conference Proceedings (attendance and presentation of paper depends on available funding): North American Association of Environmental Educators; American Society of Limnology and Oceanography; American Association for Advancement of Science/Arctic Division (abstract)

PROFESSIONAL CONFERENCES

In-Kind Funding provided for attendance and travel (not included in this proposal),:
North American Association of Environmental Educators (NAAEE);
National Association of Marine Educators (NAME)
American Society of Limnology and Oceanography
American Association for Advancement of Science/Arctic Division

NORMAL AGENCY MANAGEMENT

Neither ADFG nor NOAA require development of a citizen-monitoring programs. Through this proposal we are seeking to fund staff to design and co-manage the citizen monitoring program with a community-based nonprofit organization. We will contract the Center for Alaska Coastal Studies to implement the program.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The project will be the first Kachemak Bay program to use the products of the soon-to-be completed KBEC project. During the KBEC's research and writing process, KBNERR and ADFG coordinated with restoration projects on several fronts. We coordinated efforts with the APEX project (\163), which has a significant study effort in Kachemak Bay/Lower Cook Inlet. We provided spatial data that assisted their modeling project and will incorporate their findings in the characterization. We will coordinate with the staff of other EVOS projects (CIMMS and Mariner Park Restoration Project) to build and design appropriate research projects.

The *Tools Manual* will provide research-education guidelines for the EVOS transition to the GEM project.

PROPOSED PRINCIPAL INVESTIGATOR, IF KNOWN

Co-PI: Glenn A. Seaman
Manager, Kachemak Bay NERR
ADFG, Habitat and Restoration Division
333 Raspberry Road
Anchorage, Alaska 99518-1599
Phone: 267-2331
Fax: 267-2464
E-mail: glenns@fishgame.state.ak.us

Co-PI: Dr. Rick Foster, Ph.D.
Education Coordinator, Kachemak Bay NERR
ADFG, Habitat and Restoration Division
202 W. Pioneer Ave.
Homer, AK 99603
Phone: 235-4799
Fax: 235-4794
E-mail: rick_foster@fishgame.state.ak.us

- Co-Principle Investigator Glenn Seaman will contribute one month of his time to oversee the project.
- Dr. Foster, the other Co-Principle, will donate a minimum of three months of his time.
- Center of Alaska Coastal Studies Contract: Marilyn Sigman, Program Director of CACS will work closely with Dr. Foster and his staff in designing the program, training the volunteers, and translating the research results. She will take responsibility as the supervisor of a volunteer coordinator and data technician, and day-to-day administration of the monitoring program. See Contract Budget at end of narrative.

PRINCIPAL INVESTIGATORS

Qualifications for Glenn Seaman

From 1975 to 1980, Glenn worked with marine mammal research in Northern and Western Alaska for ADFG and NMFS. Responsibilities included: (1) field collection of biological samples and data from pinnipeds and cetaceans from coastal villages from Nome to Kaktovik; (2) completing lab analysis of specimens; (3) conducting aerial surveys; and (4) assisting in preparing publications.

Since 1980, Glenn has functioned as ADFG's Alaska Coastal Management Program (ACMP) coordinator. In that capacity, he was responsible for overseeing the development and implementation of the ACMP. He has gained an extensive understanding of the Alaska Coastal Management Program and coordinated the department's involvement in many planning, policy, and implementation issues. He has gained a very good understanding of regulatory agency needs. As the ACMP coordinator, he was responsible for developing and overseeing the completion of the department's ACMP budget and completion of all Section 309 studies. Two of the more notable 309 projects were the Kenai River Cumulative Impact Study, which assessed cumulative impacts and developed a comprehensive GIS for the Kenai River (Liepitz 1994, Seaman 1995); and the aquatic habitat restoration and enhancement studies (Parry et al 1993, Parry and Seaman 1994).

Glenn has led the state's effort to establish a NERR in Alaska that began in 1994. He has been the project manager for the Kachemak Bay Ecological Characterization Project since its inception. He is also the mentor for the NOAA/CSC Fellow.

In October 1999, Glenn was appointed as the Manager of the Kachemak Bay NERR. As the manager for the Kachemak Bay NERR, Glenn is the logical project manager for this project.

Glenn has proven his coordination abilities and consistently produces high quality products on time. He will continue to be responsible for overall project management. He will participate in a number of the meetings with EVOS researchers, coordination meetings with CSC, the 10th Annual workshop, and be responsible for overall project administrative responsibilities. Glenn's time will be donated to the project.

Qualifications for Dr. Rick Foster, Ph.D. / Habitat Biologist II; KBNERR:
Dr. Foster is a scientist and educator who was hired by KBNERR in October, 1999. Prior to that he was a college professor in Resource Ecology and Management for University of Alaska Fairbanks. He was Wildlife and Parks Researcher for Tanana Chiefs in Fairbanks. Most recently, he held a position as Environmental Specialist for Chugachmiut where he worked extensively with and provided training for Tribal Environmental Specialists and Resource Managers in the Villages of Nanwalek and Port Graham.

Rick is a credentialed teacher with over twenty year's experience as a college professor, high school biology, and sixth grade outdoor science teacher. He developed educational programs in the Western United States and Alaska schools and curricula for classroom and field campuses. Rick designed and directed research education programs based on the University of California Tahoe Research Groups' watershed research at Lake Tahoe of which he was a member. He developed the outdoor science program for the Campbell Creek Science Center in Anchorage and recently completed watershed education curricula for village schools.

OTHER KEY PERSONNEL

Marilyn Sigman
Center for Alaskan Coastal Studies, P.O. Box 2225, Homer, Alaska 99603
(907) 235-6667
(907) 235-6668 (FAX)
cacs@xyz.net

Qualifications:

Marilyn Sigman has been Program Director for the Center for Alaskan Coastal Studies since 1998. She has directed its intertidal education programs that reach 4,000 people annually and its research and monitoring efforts. She was previously Executive Director of the Montana Natural History Center from 1995-97 with similar program management responsibilities. She is experienced in the administration of educational program budgets, contracts, and grants; management of field facilities and field travel, supervision of employees, and recruitment and training of large numbers of volunteers.

Marilyn has an in-depth knowledge of Alaska's coastal ecosystems and experience in program and project management that focuses on coastal ecosystems and translating between the scientific and education communities. She was Project Director of the EPA-sponsored Tillamook Bay National Estuary Project from 1993-96 where she developed and oversaw integrated scientific/technical, citizen involvement, and watershed management planning aspects of the project; regional coordinator for the Alaska Department of Fish and Game Conservation Education and Watchable Wildlife Program in Southeast Alaska from 1990-93, and statewide

coordinator for the ADFG Wildlife Curriculum Program from 1988-92 for which she was primary writer/editor of a "Wetlands and Wildlife" curriculum that won national recognition from the Department of Interior. She was also the Regional Habitat Biologist for Southeast Alaska from 1982-88 and represented ADFG in several state area land use planning teams for management of tidal and submerged lands and on the inter-agency committee that developed regulations to implement the Alaska Coastal Management Program.

Carmen Field / Habitat Biologist I; KBNERR

Carmen is KBNERR's Education Specialist. She is a trained biologist and has worked as a professional naturalist in Alaska and throughout the world. Currently, she is the President of the Board of Directors for the Homer Society of Natural History / Pratt Museum. Over the past 13 years Carmen has taught a myriad of marine biology courses, (focusing primarily on coastal and marine ecology) to students, teachers and the general public on both coasts of North America. Carmen and her husband, Conrad, own Northcountry Nature, a small natural history publication business and recently co-authored a guide to spineless wonders of the north, *Alaska's Seashore Creatures – A Guide to Selected Marine Invertebrates*, which was published in May 1999.

Dr. G. Carl Schoch, Ph.D. / Fisheries Biologist III; KBNERR

Dr. Carl Schoch is KBNERR's Research Coordinator. He has a BS degree in Geology and Arctic Hydrology, an MS in Marine Resource Management, and a Ph.D. in Oceanography from Oregon State University (OSU). Carl has extensive experience in intertidal and benthic habitat mapping and modeling. In fact his Post-Doc at OSU entails mapping biological community patterns and developing a model that relates to physical processes along the eastern Pacific Ocean—Oregon and Washington, as part of a study "Partnership for Interdisciplinary Studies of the Coastal Ocean: A Long Term Ecological Consortium" (PISCO). His first major research project will be to begin a similar project here in Kachemak Bay.

Dr. Schoch will contribute by leading the effort to define and prioritize information needs and future Citizen Research and monitoring. This work will be integrated with researchers and general public through a "Research and Monitoring Advisory Group" that will be set up by the developing NERR. He will contribute time to regularly meet with the Citizen Researcher teams. He and Dr. Foster will mentor the "Expert Level" Citizen Researcher.

Curtis Smith/Research Analyst II; ADFG

Curtis has substantial experience in several aspect of GIS and Web Site design. He has been responsible for the GIS component of the KBEC. He will design the data collection program, Web Site, and be responsible for integrating KBEC into the program.

LITERATURE CITED

Alaska Department of Education. 1996. Science standards for Alaska students. Juneau, AK.

King, S., J. Holmes, and M. Farmer. 1997. Watershed and intertidal monitoring: volunteer training manual. Island County/Washington State University Beach Watchers. Washington State University Cooperative Extension. Coupeville, WA.

National Academy of Sciences. 1996. Science Education Standards. National Academy Press. Washington, D.C. 262 pp.

Schoch, G. C. 1999. Untangling the complexity of Nearshore Ecosystems: Examining Issues of Scaling and Variability in Benthic Communities. Un-published doctoral thesis, Oregon State University, Corvallis.

TERC and the Concord Consortium. 1997. National Conference of Student and Scientist Partnerships. Conference Report. TERC. Cambridge, MA. 147 pp.

KBEE Alliance MEMBER GROUPS (As of March 6, 2000)

UAF Marine Advisory Program

S.O.S. Response Team

Kachemak Bay Conservation Society

Center for Alaskan Coastal Studies

Kenai Peninsula College - Kachemak Bay Campus

KBNERR

AK Maritime National Wildlife Refuge

Pratt Museum/Homer Society of Natural History

Cook Inlet Keeper

Prince William Sound Regional Citizen Advisory Council (RCAC)

IDEA (Iditarod Distance Education Association)

City of Seldovia

Tribal village of Port Graham

Tribal village of Nanwalek

Cook Inlet Region Citizen Advisory Council (CIRCAC)

Seldovia Native Association

UAF - Kasitsna Bay Lab (also HOST for March 2000 KBEE Workshop)

K-12 Teachers

POTENTIAL KBEE MEMBERS (planning meetings, interested but could not send a representative).

Kachemak Heritage Land Trust

The Nature Conservancy of Alaska

Nanwalek IRA Council

Port Graham Village Council

Port Graham Corporation

Alaska State Parks

Alaska Wilderness Recreation & Tourism Association

City of Homer

Rainbow Tours

2001 EXXON VALDEZ TR E COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001						
Personnel		$48.3						
Travel		$1.6						
Contractual		$50.2						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$100.1				Estimated FY 2002		
General Administration		$10.8						
Project Total	$0.0	$110.9				$58.0		
Full-time Equivalents (FTE)		1.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: In-kind personnel services: Seaman, P.I. @ 1 month; Foster, P.I. @ 3 months; Field @ 1 month; Schoch @ 1 month.
FY 2002 estimate of $58.000 includes a contractual rate of $17.7 for CACS; printing costs @ 3.000; ADF&G/NERR personnel: Foster @ 2 months, Field @ 3 months, Smith @ 1.4 months,and travel @ $2.4.

FY01

Prepared:

Project Number: 01384
Project Title: Kachemak Bay Citizen Researcher Program
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TF :E COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2001
Dr. Rick Foster	Habitat Biologist II	16B	3.0	4.5		13.5
Carmen Field	Habitat Biologist I	14B	6.0	3.9		23.4
Curtis Smith	Research Analyst II	16A	1.5	4.2		6.3
Dr. Carl Schoch	Fisheries Biologist III	18B	1.0	5.1		5.1
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		11.5	17.7	0.0	
					Personnel Total	$48.3

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2001
Two Round Trips Between Homer and Anchorage	0.2	2	4	0.1	0.8
Four Round Trips Between Homer and Port Graham/Nanwalek/Seldovia	0.1	6	2	0.1	0.8
Two Round Trips Between Homer and Cordova (FY 002)	3.5	2	4	0.1	
Two Round Trips Between Homer and Seward (FY 002)	0.1	2	1	0.1	
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.6

FY01

Prepared:

Project Number: 01384
Project Title: Kachemak Bay Citizen Researcher Program
Agency: Alaska Department of Fish and Game

FORM 3B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TR E COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed
Description	FY 2001
Center for Alaska Coastal Studies: Design, Management, Implement, Evaluate Pilot Projects (See Breakdown in Narrative Section)	48.7
Printing Costs: Citizen Researcher Tools Manual	1.5
Printing Costs: Train the Trainer Manual @ 2.000 (FY 2002)	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$50.2

Commodities Costs:	Proposed
Description	FY 2001
Commodities Total	

FY01

Project Number: 01384
Project Title: Kachemak Bay Citizen Researcher Program
Agency: Alaska Department of Fish and Game

FORM 3B
Contractual & Commodities DETAIL

Prepared:

2001 EXXON VALDEZ TR :E COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2001
			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	Inventory
Description	of Units	Agency
PC Computers	2	ADF&G
FAX	1	ADF&G
Printer	2	ADF&G
Vehicle (VAN)	1	ADF&G
Photocopy	1	ADF&G
Photocopy	1	CACS
Mac Computers	2	CACS
Printer	2	CACS
FAX	1	CACS

FY01

Project Number: 01384
Project Title: Kachemak Bay Citizen Researcher Program
Agency: Alaska Department of Fish and Game

FORM 3B
Equipment
DETAIL

Prepared:

PROJECT TITLE: Modeling Biodiversity in Kachemak Bay: A Proposal to Map Marine Nearshore Habitats at Nested Spatial Scales

Project Number:	01385
Restoration Category:	Ecosystem Synthesis, General Restoration (suggested)
Proposer:	ADFG/Kachemak Bay National Estuarine Research Reserve (KBNERR)
Lead Trustee	ADFG
Duration:	2-year project
Cost FY 01:	$101.4
Cost FY02:	$80.5
Cost FY03:	$23.2
Geographic Area:	Kachemak Bay, Southern Kenai Peninsula, and Lower Cook Inlet

Injured Resource/Service: Kachemak Bay includes all resources injured by the oil spill (except cutthroat trout, Dolly Varden, and AB Killer Whale pod), intertidal communities, and all the lost or reduced services.

ABSTRACT

The increasing number of stresses on estuarine ecosystems has challenged resource agencies and scientists to find a method for determining rates and spatial extents of ecological effects due to changes in environmental conditions. One significant problem that masks these changes is the large natural fluctuation of biological populations in space and time. Furthermore, no method exists to extrapolate data collected from local sites to large areas. A method developed in Alaska (Cook Inlet and Shelikof Strait), the Olympic Coast National Marine Sanctuary and in Puget Sound, partitions complex shorelines into physically homogeneous segments to minimize the variability of the biological community caused by physical forces. Groups of similar segments can then be aggregated to extrapolate biological transect data collected from small areas to larger spatial scales. This method is proposed for implementation in Kachemak Bay, with over 285 miles of shoreline, as a first step in monitoring estuarine biodiversity. Data collected under this study would provide a basis for monitoring estuarine, intertidal biodiversity over time, and would be an important technology and tool for the Gulf Ecosystem Monitoring (GEM) project. This cost-effective methodology can be applied to other estuarine ecosystems in the spill-affected area.

INTRODUCTION

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

This project will benefit the recovery and maintenance of intertidal communities and multiple other resources injured by the spill. It will also result in detailed information on the physical characteristics and biological composition of intertidal and near subtidal communities in the Kachemak Bay area. Moreover, this project will have a positive effect on the recovery and management of lost or reduced human services. These include commercial fishing (e.g., clams and finfish), recreation and tourism (e.g., activities oriented around the unique intertidal resources that Kachemak Bay provide), subsistence, and passive uses. Information and tools derived from this project will be instrumental in making management decisions related to injured resources and uses. The utility of this information will be greatly enhanced through the development of physical oceanographic information we hope to obtain through partners or future funding sources.

NEED FOR THE PROJECT

Statement of Problem

Monitoring biological communities for a response to natural or anthropogenic perturbations encounters two fundamental problems. The first is the large temporal and spatial variability of organism abundance in natural ecosystems, which masks our ability to statistically separate an actual change caused by a perturbation from natural cycles. Second, extrapolating or generalizing the results of localized studies to broad areas is fraught with problems; yet biological sampling is too labor-intensive to attempt everywhere (Underwood & Petraitis 1993). One solution in the marine realm involves systematic quantification and minimization of physical gradients among sample sites. The application of a shoreline partitioning model (Shoreline Classification and Landscape Extrapolation: SCALE) increases biological homogeneity by segmenting a shoreline into a spatially nested series of geophysically uniform units. By then statistically aggregating similar but spatially separated units, biological data collected from localized transects can be scaled up to larger regions.

Rationale/Link to Restoration

In addition to benefiting injured resources and services affected by the spill (see introduction), is a response to a request for new projects in Invitation to Bid under Ecosystem Synthesis: "Innovative Tools and Strategies to Improve Monitoring." This project will develop and implement an innovative, cost-effective technology that resource managers can use to enhance their understanding of the biology and habitat of fish and wildlife. This is critical step in establishing a long-term monitoring program. With the physical oceanographic studies we hope to begin with NOAA and other funds, this will be an important step to monitoring biological diversity and changes in intertidal communities and abundance of associated fish and wildlife resources over time. Moreover, this project will further help managers detect natural and anthropogenic changes in intertidal communities, and re-evaluate management strategies.

Other links to the restoration effort are summarized below in relation to the policies of the Trustees Council.

Ecosystem Approach, Policies 1 and 2 – A primary focus of this project is to develop and implement a strategy to promote an ecosystem approach towards restoration, management, and use of Kachemak Bay. The study area includes the Kachemak Bay Watershed, encompassing those lands purchased by the Trustee Council on the north and south side of the Bay.

Injuries Addressed by Restoration, Policies 3, 4, and 6 – This project addresses restoration and monitoring environmental conditions related to injured species and services. Many of the injured species and services have substantial economic, cultural, and subsistence value to the state, regional, and local economies.

Location of Restoration Actions, Policy 8 – Kachemak Bay is in the area spill-affected area.

Restoring a Service, Policy 9 – Most of the injured services occur within the Kachemak Bay area.

Efficiency, Policies 11 and 14 – This project provide significant cost sharing. The EVOS restoration effort can gain significant benefits from this product with relatively little expense.

Partnerships, Policy 15 – The project will both establish partnerships with NOAA and provide strong foundation for future partnerships.

Clear, Measurable, and Achievable Endpoint – This project will be completed in mid FY02. The products will be available to managers, researchers, local governments, and the public.

Access to Information and Data, Policy 20 – This project will make information on this project available the public, agencies, and managers though a CD and the Internet.

Normal Agency Activities – The mapping and modeling of intertidal and subtital communities is not a required normal agency activity of the Kachemak Bay National Estuarine Research Reserve (KBNERR), and no funding is provided by NOAA or the state to Research Reserves for this purpose. We have tried to establish partnerships and joint resources to bring this important project to relative to provide the best use and benefit to the EVOS restoration and long-term monitoring effort.

C. Location

The location of this specific study is the Kachemak Bay/Lower Cook Inlet Area. The immediate benefits of this study will be realized in greater Kachemak Bay area, but can be applied in other geographic areas. The most directly affected communities including to areas/communities of Homer, Seldovia, Halibut Cove, Port Graham, and Nanweluk.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The KBNERR has already used several forums to present this project in concept to the management agencies and the general public. This project was received with great enthusiam by both management agencies and community representatives. We will continue to keep the community apprised of our progress. Results will be made to the management agencies as them become available.

A related project proposed by the KBNERR in partnership with the Center for Alaska Coastal Studies (#01384) will specifically provide for extensive community involvement in research and monitoring. While these could be undertaken independently, they would greatly complement each other if undertaken concurrently.

PROJECT DESIGN

A. Objectives

1. To map the nearshore habitats in Kachemak Bay and quantify the physical attributes that force spatial variation in biodiversity of algal and invertebrate populations from characteristic habitat types in the Bay;

2. To measure the temporal variation of nearshore biodiversity among similar but spatially independent habitat types along the strong physical gradients of the Bay;

3. To test how well the SCALE model predicts benthic community structure at small and large spatial scales; and

4. To test the application of the SCALE model in the subtidal zone (to 10 m).

B. Methods

The approach for minimizing biological variability is to segment complex biogeochemical shoreline gradients using a combination of qualitative and quantitative partitioning criteria. Previous studies have often failed to develop quantitative links between specific intertidal assemblages and physical attributes of habitats, thus making it impossible to "scale up" in either time or space from limited *in situ* sampling (Menge et al., 1997). The proposed shoreline classification model addresses the needs of coastal ecologists seeking to make comparisons among spatially independent beach sites. This model relies on quantification of physical features known to have direct and indirect ecological responses, and uses these as criteria for partitioning complex shorelines into a spatially nested series of homogeneous segments. For example, at small spatial scales the quantified geophysical parameters include sediment grain size, wave energy, substrate dynamics, and sediment chemistry. At large spatial scales water chemistry attributes such as salinity, chlorophyll and nutrient concentrations are used. These nested segments can be used to study between-segment and within-segment variability, which in turn will support studies of the biotic and abiotic processes that control variability. This segment approach allows large areas of shoreline to be classified based on relatively limited *in situ* sampling. The results of on-going research in Alaska (Cook Inlet and Shelikof Strait), Puget Sound and the outer Olympic Peninsula of Washington, has shown this to be a robust approach, despite the enormous complexity of these regions (Schoch & Dethier 1996, and in review). The variance among populations sampled from a group of identical but spatially independent habitats are consistently not different from the variance within any one of the group communities. These results imply that the effects of a perturbation on a community or population from one segment can be compared to a community or population from a physically identical but undisturbed segment within the same group of habitats.

The proposed study site will include all of Kachemak Bay and the smaller fjords and inlets along the southern shore. During Year 1 of this study, homogeneous alongshore segments (10-100 meters in length) will be delineated and characterized by up to ten geophysical parameters within each of three intertidal zones. These partitions result in three intertidal polygons nested within each alongshore segment. Alongshore segments are grouped within oceanic blocks to control for variations in salinity, temperature, nutrients and wave energy. These physical data provides the required information for the second year of the proposed study when epiflora and fauna (in quadrats), and infauna abundances (in cores) will then be sampled from randomly selected segments in the SCALE geophysical database that characterize the largest percentage of shore length and area.

Data Analysis

Multivariate analyses (nonmetric multidimensional scaling) of organism abundance will be used to evaluate the variation at different spatial scales (within segments, and within and among groups of segments) for each substrate type at each elevation or zone. Statistical significance and relative homogeneity will be tested at each spatial scale. "Indicator values" will be calculated for each species, combining information on frequency and abundance in a particular group of samples (Dufrene & Legendre 1997). Matrices of indicator values for each tide level will be analyzed to determine the organisms consistently driving the differences among segments and among groups. A nested ANOVA model will be used to analyze the spatial scales at which taxa are best at detecting change at any given scale. At each spatial scale, multivariate ordination plots of the biota will illustrate consistent patterns of within-group homogeneity compared to among-group heterogeneity. Statistical significance of relative group separation will increase with geophysical heterogeneity. Thus, the data is hypothesized to show that we can never generalize the entire community structure over all spatial scales because of the inherent introduction of geophysical and biological heterogeneity as spatial scales increase. However, the results of indicator species analysis and the nested ANOVA analysis will show that subsets of the community can be scaled up while retaining statistical similarity ($p>0.05$), although the number of individual organisms in each subset decreases with increasing spatial scale.

Year 1 Methods Summary

1. Use low altitude aerial videography of the coastal zone for large scale (100-1,000 m linear) partitioning of the shoreline based on shore geomorphology, geophysical and biological characteristics of the nearshore, and characteristics of the upland watershed.

2. Field map the shoreline (on the ground) to partition the beach into geophysically homogeneous segments (10-100 m linear), quantifying the geophysical attributes known to force biological communities in the nearshore;

3. Develop a GIS database of physical habitat features for intertidal and subtidal lands in the KBNERR and analyze the statistical distribution of characteristic habitat types in preparation for the Year 2 biological sampling program.

C. Cooperating Agencies, Contracts, and other Agency Assistance

Cooperating Agencies/Contracts: ADFG is the only trustee agency requesting financial assistance under this award. There will be no contracts to other Trustee Agencies. ADFG will contract for $30,000 to obtain the required aerial videography.

Other Agency Assistance:

NOAA/Office of Ocean and Coastal Resource Management/Research Reserve Division (RRD) – As part of its operations award from NOAA, RRD will provide limited funds to participate in the National Estuarine Reserve System's (NERRS's)) System-wide Monitoring Program. This monitoring program currently includes the deployment and maintenance of data loggers (to measure salinity, temperature, dissolved oxygen, pH, and turbidity) and a weather station. As a new reserve, the KBNERR will be defining its participation in this program next fiscal year. Most of the operations funds for this program this year will go to staff time in designing the program

In addition, NOAA has agreed to provide an additional $25,000 next year to the KBNERR – over and above operations funds – for purchase of several data loggers and a weather station in . These funds are provided on a 70% federal/30% non-federal basis, although we do not have the funds to meet this match requirement. The proposed EVOS project (#01385) will allow us to satisfy this match requirement and begin deployment of this equipment in Federal FY01.

NOAA/Coastal Services Center (CSC) – In a cooperative effort, the Alaska Department of Fish and Game/KBNERR and NOAA are undertaking the Kachemak Bay Ecological Characterization Project (partially funded by EVOS Trustees Council under #00278). As part of this partnership, the CSC will provide the high resolution aerial photography in a digital format. This will satisfy the aerial photography needs of this project.

ADFG Clam Surveys – The Commercial Fisheries and Sport Fish divisions are planning to conduct clam surveys in Kachemak Bay and will likely continue to do so next summer. The KBNERR and other divisions will coordinate their efforts to maximize efficient use state and other project funds.

SCHEDULE

A. Measurable Project Tasks for FY01

- December 2000 – complete draft plan for deployment of data loggers and weather station in Kachemak Bay
- February 2001 – complete planning for FY01 field season
- September 2001 – complete:
  1) physical and biological shore map of all of Kachemak Bay (low resolution map of all physical habitats)
  2) high resolution, on the ground physical habitat mapping
  3) GIS database that will archive all of 1 and 2

B. Project Milestones and Endpoints (tasks funded in part by EVOS)

Overall Products (from two-year effort, includes portion funded by EVOS)

1. The Shore-Zone geomorphological classification and biological inventory of all Kachemak Bay shorelines consistent with the marine classification used to map British Columbia and Washington State (100-1000m);

2. A high spatial resolution (10-100 m) GIS database consisting of a digital intertidal habitat map of Kachemak Bay and the associated physical attributes for each across-shore polygon;

3. A spatial database of biota sampling results for the most characteristic habitats in the Bay;

4. Statistical analyses of segment community comparisons within and among the selected shore segments as outlined above;

5. A CD-ROM and final report detailing the procedures used and the results obtained, for distribution to the public. This project will also be included on the Internet, available to all members of the public.

C. Completion Date

We propose to complete this habitat mapping and modeling project in a little over two years. We have included a few months of staff time in beginning of year 3 to complete the analysis, report, and CD/Internet products. For purposes of expediency and to keep project costs down, the department has proposed in this project to only focus on the habitat mapping and modeling component. An oceanographic component should be developed to more fully assess and monitor natural and human changes to the ecosystem. The KBNERR will begin this process in FY01 through initial development of the KBNERR's participation in the NERRS's system-wide monitoring program.

PUBLICATIONS AND REPORTS

The PI will seek to publish the results of this project in a major peer-reviewed journal following the completion of second year work. The KBNERR may request funding for this purpose following the second year per Trustee guidelines.

PROFESSIONAL CONFERENCES

The PI will attend a professional conference and present a paper on this project in year 2. Funds will be included in next year's budget for this purpose.

NORMAL AGENCY MANAGEMENT

Neither ADFG nor NOAA requires by statute, regulation, or policy to undertake habitat mapping and modeling to be undertaken by Research Reserve. The KBNERR does not receive adequate operation funds for this purpose, which largely dedicated to Research Reserve Administration and system-wide research and education initiatives. Consequently, the Research Reserve must seek other sources of funding and create parternerships to complete these tasks.

COORDINATION AND INTEGRATION WITH THE RESTORATION EFFORT

Coordination with the EVOS Restoration Effort:

USGS/Biological Research Division (BRD) – The KBNERR will be using the oceanographic information developed by John Piatt, BRD, in Kachemak Bay. With Dr. Piatt winding down his studies in the region, we anticipate utilizing his phytoplankton and related oceanographic data as part of the proposed project and related NERR efforts. While the details are still being developed, this coordination will save BRD and EVOS Trustees money and help continue and expand important data sets funded by these programs.

FWS (potential) – The KBNERR has submitted a proposal under the FWS Coastal Management Program to continue and expand Dr. John Piatts work to measure the chlorophyll fluorescence, salinity, temperature and transmissivity distributions for Kachemak Bay/Lower Cook Inlet by monthly profiles over a 1 km grid for a period of three years. We requested funds to purchase a Seabird SEALOGGER CTD *SBE 25* profiler with a WetStar Fluorometer, and a small field computer. This would allow the KBNERR to map the spatial and temporal variation of estuarine and oceanic phytoplankton concentrations in Kachemak Bay/Lower Cook Inlet, Alaska. Determining the spatial and temporal distributions of primary productivity is the first step in a science-based marine conservation strategy. Since primary production drives all other trophic levels, a partial list of resources enhanced by the proposed work include: fisheries with commercial stocks of salmon, rockfish, crabs, and shellfish, kelp bed communities (kelp, urchins, sea otters), seabirds and shorebirds.

Other Funds/Major Contributors:

Please see "C. Cooperating Agencies, Contracts, and Other Agency Assistance" for contributions from NOAA and FWS (potential contributor). A summary of other funds and in-kind contributions are also summarized in the budget.

PRINCIPAL INVESTIGATOR

Carl Schoch, Ph.D.
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333 Raspberry Road
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Qualifications:

Dr. Schoch has extensive experience on oceanographic cruises and developed the SCALE methods of shoreline habitat modeling (see attached resume). Dr. Schoch will be responsible for the development of the habitat classification system, and the collection, processing and delivery of all subtidal and intertidal data, as well as oceanographic data made possible through other funding sources in year 1.

OTHER KEY PERSONNEL

An experienced marine technician will be hired to assist Dr. Schoch with the field sampling and data analysis. Mr. Curtis Smith is manager of the data archiving and dissemination. Mr. Smith will be responsible for the GIS component of the project. He also has extensive experience with GIS datasets.

LITERATURE CITED

Dufrene, M., and P. Legendre 1997. Species assemblages and indicator species: the need for a flexible asymmetrical approach. *Ecological Monographs* 67:345-366.

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

Schoch, G.C., and M. N. Dethier, 1996. Scaling up: the statistical linkage between organismal abundance and geomorphology on rocky intertidal shorelines. *Journal of Experimental Marine Biology and Ecology* 201: 37-72.

Schoch, G.C. and M. N. Dethier, in review. Biophysical coupling in marine ecosystems: examining issues of scaling and variability in intertidal communities. *Ecological Monographs*.

Underwood, A. J., and P.S. Petraitis, 1993. Structure of intertidal assemblages in different locations: how can local processes be compared? Pages 39-51 in R. E. Ricklefs

and D. Schluter, editors. *Species Diversity in Ecological Communities*. Univ. of Chicago Press, Chicago.

Dr. G. CARL SCHOCH

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Education

Ph.D., Oceanography 1999, College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, Oregon 97331

MS., Marine Resource Management, 1996, College of Oceanic and Atmospheric Sciences, Oregon State University

Post-baccalaureate in Arctic Hydrology, 1981-1984, University of Alaska, Anchorage, AK

BS Geology, 1977, Oregon State University

Academic Fellowships

NASA science team member for the LEWIS satellite and hyperspectral imager (1995-1998), to design and coordinate science projects for the imager data.

NOAA, Sanctuaries and Reserves Division Fellowship (1995-1996), to study landscape scale ecological patterns in the marine nearshore of the Olympic National Marine Sanctuary.

Research Grants and Contracts

Washington State Department of Natural Resources, 1997-present, a series of grants through the University of Washington to test habitat classifications and ecological models for the deterministic organization of nearshore communities in Puget Sound.

Olympic Coast National Marine Sanctuary, 1998, nearshore GIS model development.

Washington State Department of Ecology, 1996-1997, 1-year contract to develop a GIS intertidal habitat database for the outer Olympic coast.

University of Alaska, 1997, provided funding to develop an intertidal habitat database for Katmai National Park.

National Park Service, 1994-1996, 2-year grant to model intertidal habitats in Cook Inlet, Alaska.

Professional and Miscellaneous Experience

April 2000- present, Science Coordinator, Kachemak Bay NERR, Homer, AK.

July 1999 – June 2000, PISCO research associate to Bruce Menge and Jane Lubchenco

1999-present, Research Science Chair on the Olympic Coast Sanctuary Advisory Council

1991-1993 Sailed the 30' ketch 'Elisabeth', solo around the world

1989-1991 Coastal Ecologist, National Park Service, Anchorage, AK
1987-1991 Instructor for the National Outdoor Leadership School (NOLS)
1980-1986 Surface Water Hydrologist, R & M Consultants Inc., Anchorage, AK.
1979-1980 Cartographer, US Geological Survey, Denver, CO and Anchorage, AK
1977-1979 Commercial Diver, Ocean Systems, Inc., Houston, Texas.

Memberships

Pacific Estuarine Research Society
American Geophysical Union
American Society for Limnology and Oceanography

Relevant Publications

Schoch, G.C., and M.N. Dethier, 2000. The spatial and temporal variability of shoreline biota in South and Central Puget Sound. A report to the Washington Department of natural Resources, Olympia, WA. 122 pp.

Schoch, G.C., J. Harper, and M.N. Dethier, 1999. The physical classification and biological modeling of nearshore and estuarine habitats in Carr Inlet, Puget Sound. A report to the Washington Department of natural Resources, Olympia, WA. 72 pp.

Schoch, G. C., M. N. Dethier. The spatial structure of intertidal invertebrates among sandy pocket beaches on the outer Olympic Peninsula coast (in prep).

Schoch, G.C., J. Harper, and M.N. Dethier. Identifying replicate beaches in the nearshore: partitioning the heterogeneity of complex shorelines. *Estuarine, Coastal and Shelf Science* (submitted).

Schoch, G. C., and M. N. Dethier. Spatial and temporal comparisons of nearshore benthic communities in Puget Sound. *Ecological Monographs* (in revision).

Schoch, G. C., and M. N. Dethier, 1998. Mapping shorelines in Puget Sound I: A spatially nested geophysical shoreline partitioning model. *1998 Proceedings: Puget Sound Research Conference*, Seattle, WA, 9 pp.

Dethier, M. N., and G. C. Schoch, 1998. Mapping shorelines in Puget Sound II: Linking biota with physical habitats. *1998 Proceedings: Puget Sound Research Conference*, Seattle, WA, 8 pp.

Schoch, G. C., 1998. Nearshore ecosystems: are they healthy? *Exclusive Economic Zone Technology*, 2:27-32.

Dethier, M.N., and G.C. Schoch, 1998. Linking marine habitat types with organisms: conserving biodiversity via preserving habitats (abstract only), *Marine Conservation Society Meeting*, Victoria, B.C.

Dethier, M.N., G.C. Schoch, and L. Tear, 1997. Optimizing sampling designs for describing and detecting changes in rocky shore communities (abstract only), *25th Benthic Ecology Meeting*, Portland ME.

Schoch, G. C., and M. N. Dethier, 1996. Scaling up: the statistical linkage between organismal abundance and geomorphology on rocky intertidal shorelines. *Journal of Experimental Marine Biology and Ecology*, 201:37-72.

2001 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001						
Personnel		$53.6						
Travel		$0.5						
Contractual		$32.0						
Commodities		$5.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$91.1	Estimated FY2002	Estimated FY2003				
General Administration		$10.3						
Project Total	$0.0	$101.4	$80.5	$23.2				
Full-time Equivalents (FTE)		1.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Other Contributions In Year 1:

1. NOAA/CSC -- provide aerial photography in digital format (before startup of the project) -- no cost estimate of NOAA time available
2. NOAA/OCRM/Research Reserve Division -- $25.0 data logger and weather station purchase (dependent on EVOS funding to meet the match requirement)
3. ADF&G/KBNERR -- Glenn Seaman, Reserve Manager (1 month of support for administrative and management support), Dr. Carl Schock (3 months additional support from NERR operations funds dedicated to development of KBNERR monitoring plan, use and deployment of data loggers and weather stations and other oceangraphic equipment, if funded)
4. FWS (*proposed project*) -- $30.0, for SEALOGGER CTD SBE 25 profiler with a WetStar Fluorometer and small notebook computer

FY01

Prepared:

Project Number: 01385
Project Title: Modeling Biodiversity in Kachemak Bay: A Proposal to Map Marine Nearshore Habitats at Nested Spatial Scales
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2001
G. Carl Schoch, Ph.D.	Research Coordinator	18A	5.0	5.0		25.0
Vacant	Marine Tech/Habitat Biologist	14A	5.0	4.0		20.0
Curtis Smith	Research Analyst II	16B	2.0	4.3		8.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		12.0	13.3	0.0	
					Personnel Total	$53.6

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2001
Travel to EVOS Annual Meeting	0.2	1	3	0.1	0.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.5

FY01

Prepared:

Project Number: 01385
Project Title: Modeling Biodiversity in Kachemak Bay: A Proposal to Map Marine Nearshore Habitats at Nested Spatial Scales
Agency: Alaska Department of Fish and Game

FORM 3B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed
Description	FY 2001
Telephone	2.0
Aerial Videography	30.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$32.0

Commodities Costs:	Proposed
Description	FY 2001
Boat Gasoline and Maintenance Costs	3.0
Field Materials and Supplies	2.0
Commodities Total	$5.0

FY01

Prepared:

Project Number: 01385
Project Title: Modeling Biodiversity in Kachemak Bay: A Proposal to Map Marine Nearshore Habitats at Nested Spatial Scales
Agency: Alaska Department of Fish and Game

FORM 3B
Contractual & Commodities DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2001
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Personal Computers or Workstations	2	ADFG
22 Foot Boat for Field Surveys	1	ADFG

FY01

Project Number: 01385
Project Title: Modeling Biodiversity in Kachemak Bay: A Proposal to Map Marine Nearshore Habitats at Nested Spatial Scales
Agency: Alaska Department of Fish and Game

FORM 3B
Equipment
DETAIL

Prepared: