

Final Data Analyses and Manuscript Preparation - Prince William Sound Harbor Seal Studies.

Project Number: 01064
Restoration Category: Monitoring
Proposer: Kathryn J. Frost, ADF&G
Lead Trustee Agency: ADF&G
Cooperating Agencies: none
Alaska Sea Life Center: no
Duration: 1 year
Cost FY 01: \$ 25,100
Geographic Area: Prince William Sound
Injured Resource: Harbor Seals

ABSTRACT

During 1989-1999, the EVOS Trustee Council funded ecological studies of harbor seals in Prince William Sound under project 064, entitled "Monitoring, Habitat Use, and Trophic Interactions of Harbor Seals in Prince William Sound, Alaska." Those studies monitored population status, documented movements and habitat use, and investigated what factors could be responsible for the population decline that was ongoing prior to the spill and that continued thereafter. To date, some of the results of those studies have been published in scientific journals. Additional manuscripts are being prepared and will be submitted during spring and summer 2000.

At the termination of project 064 in September 2000, some data will remain unanalyzed and unpublished. In particular, funding for FY00 includes aerial surveys of the PWS trend count route in mid to late August 2000. Data analysis from those surveys cannot be complete by project termination. Furthermore, several satellite tags attached to seal pups in June 1999 were still transmitting in April 2000. Data from those tags will not be analyzed by project termination. A complete analysis of PWS seal pup tagging data must include 1999-2000 data, as well as data for previous years.

This proposal is to cover analysis and final write-up of the following: a) August 2000 harbor seal aerial surveys; b) a comparison of 2000 counts with previous years (i.e., an updated analysis of population trend); c) 1999 seal pup tagging data; and d) integration of 1999 pup tagging data with other years and a synoptic analysis of movements and diving behavior of harbor seal pups in PWS.

INTRODUCTION

Harbor seals (*Phoca vitulina richardsi*) were one of the wildlife resources damaged by the March 1989 Exxon Valdez oil spill (EVOS) (Frost et al. 1994, Lowry et al. 1994, Spraker et al. 1994). The number of harbor seals in central and eastern Prince William Sound (PWS) was declining before the spill (Frost et al. 1994) and has continued to decline ever since, with an overall reduction in population size of 57% during 1984-1998 (Frost et al. 1999a).

Harbor seal studies began almost immediately after the spill as part of the Natural Resources Damage Assessment (NRDA) program. NRDA studies were conducted by the Alaska Department of Fish and Game (ADF&G), and included aerial surveys to quantify mortality and necropsies to document levels of hydrocarbons and tissue damage in oiled seals. Beginning in 1991 as NRDA studies neared completion, the EVOS Trustee Council funded a harbor seal Restoration Science Study in which ADF&G continued to monitor the trend of harbor seals in PWS and began a research program to investigate the causes of the ongoing population decline. Initially the harbor seal restoration study addressed a broad array of possible causes for the decline including disease, predation, human-caused mortality, reproduction, and food limitation (Frost et al. 1995, 1996).

Investigations conducted in PWS as part of Restoration Study 064 indicate that disease, poor pup production, or emigration are unlikely as causes for the decline. Population modeling studies have suggested that poor survival of juvenile seals was a likely factor, and that the carrying capacity for harbor seals in PWS may have declined (Frost et al. 1996). Consequently, the focus of investigations shifted to studies of harbor seal feeding ecology (Frost et al. 1997, 1998, 1999a). During 1994-1996 we addressed this question relative to adult and subadult segments of the population, and in 1997-1999 for pups and yearlings. Major components of this study have included tagging with satellite-linked depth recorders to study movements and diving behavior, and the determination of diets based on analysis of fatty acid signatures in harbor seal blubber and in their potential prey. Most recently studies have included use of isotope dilution to measure the body fat composition of animals. These analyses indicate substantial geographic, interannual, age, and gender related differences in harbor seal movement patterns, diversity and species composition of diets, and body composition.

FY 2000 has been a close-out year for project 064. The final field season for tagging and sampling harbor seal pups and yearlings was conducted in June-July 1999. Satellite transmitters were attached to seven harbor seal pups at that time. Aerial surveys were conducted in August 1999. Final analysis of blubber and prey fatty acids was completed, as well as deuterium oxide equilibration experiments to determine body composition of PWS harbor seals pups and yearlings. Major effort has been expended on final analysis of movements and diving data for harbor seal adults and subadults tagged in 1992-1996. However, not all of the final analysis will be complete by project termination in September 2000.

We anticipate that the following papers and manuscripts will have been published or submitted for publication by the end of the current FY 00 fiscal year:

- 1) Frost, K. F, Lowry, L. F., and Ver Hoef, J. M. 1999. Monitoring trends of harbor seals in Prince William Sound, Alaska, after the *Exxon Valdez* oil spill. *Marine Mammal Science* 15(2): 494-506.

- 2) Frost, K. J., Simpkins, M. A., and Lowry L. F. Diving behavior of harbor seals in Prince William Sound, Alaska, 1992-1996. *Marine Mammal Science*. (to be submitted early May 2000)
- 3) Iverson, S. J., Field, C., Bowen, W. D., and Blanchard, W. Quantitative fatty acid signature analysis: statistical modeling of marine mammal diets from fat stores. *Ecology*.
- 4) Iverson, S. J., Frost, K. J., and Lang, S. Fat and fatty acid composition of fish species in Prince William Sound, Alaska: variation with species, habitat and diet. *Canadian Journal of Fisheries and Aquatic Sciences*.
- 5) Iverson, S. J., Frost, K. J., and Burns, J. M. Links between diet and energy storage in juvenile harbor seals in Prince William Sound, Alaska. *Journal of Animal Ecology*.
- 6) Lowry, L. F., Frost, K. J., Ver Hoef, J. M., and DeLong, R. Movements of satellite-tagged harbor seals in Prince William Sound, Alaska, 1992-1997. *Marine Mammal Science*. (to be submitted early May 2000)
- 7) Ver Hoef, J. M., and Frost, K. J. Bayesian hierarchical models for estimating harbor seal trends in Prince William Sound, Alaska. (*Journal to be determined*)

Proposed work in 2001. During FY 2001 we propose to conclude final write-up and manuscript preparation for aspects of study 064 that could not be completed prior to September 2000. This will include the following: analysis and write-up of aerial surveys conducted in August 2000; an updated trend analysis for PWS harbor seals for 1989-2000; analysis of 1999 seal pup tagging data (some tags are still transmitting as of April 2000); integration of 1999 pup tagging data with other years for a synoptic analysis of movements and diving behavior of harbor seal pups in PWS.

NEED FOR THE PROJECT

A. Statement of Problem

From 1984-1988, harbor seal counts at 25 trend sites in PWS declined by 43% due to unknown causes. The decline continued in 1989, aggravated in oiled areas by the EVOS. Counts of seals at oiled trend count sites declined by 45%, compared to 11% at unoiled sites. More than 300 harbor seals (36% of the estimated total population in oiled areas) were estimated to have died in PWS due to the spill (Frost et al 1994).

During 1990-1998, harbor seal numbers in the trend count area of PWS continued to decline at an average rate of about 2.4% per year. There were 18% fewer seals in 1998 than in 1990, and 57% fewer than in 1984 (Frost et al. 1999a). It appears that the decline has slowed in recent years and the PWS harbor seal population may be starting to stabilize, but future surveys will be required to confirm that.

B. Rationale

Harbor seals are important to residents of PWS for subsistence. In 1985-1989, harbor seals made up 13%-27% of the subsistence foods harvested in Tatitlek and Chenega Bay. During 1992-1995, the annual harvest at those two villages was less than half of what it was before the spill. Native residents have noted the scarcity of seals and the impact that has had on subsistence

hunting. Harbor seals are also watched and photographed by tourists and recreational users of PWS, and they interact with and are incidentally killed by commercial fisheries.

Like all marine mammals, harbor seals have special federal protection under the Marine Mammal Protection Act. Because of the ongoing decline, it is essential that current population data be available so that inappropriate restrictions on human activities are not implemented. The National Marine Fisheries Service is currently conducting a Population Viability Analysis for harbor seals in Alaska. This analysis will be used to determine whether harbor seals have declined to such a degree that they should be listed as depleted under the MMPA, or threatened/endangered under the Endangered Species Act.

Aerial surveys have documented the downward trend in PWS harbor seal abundance and have provided the information needed to determine whether the recovery objective of “stable or increasing population trend” has been met in the spill area. However, they are not adequate for determining what is causing the seal population to decline, or whether it is realistic to expect the population to increase given existing carrying capacity in PWS.

The Restoration Program has funded a strong field research program to test hypotheses about the health, condition, and foraging behavior of harbor seal adults and sub-adults within PWS. In recent years, attention has been focused more on the youngest age classes within the population, pups and yearlings. This attention is warranted because survival rates of juveniles are significantly lower than for older animals, and recruitment of juveniles is critical for population recovery. It is essential that these data are completely analyzed and published in the peer-reviewed literature.

C. Location

This project entails no field work. It will be conducted out of the ADF&G office in Fairbanks.

COMMUNITY INVOLVEMENT

Information will be presented at the 2001 oil spill symposia, where the general public may learn about results of this study.

PROJECT DESIGN

A. Objectives

1. Analyze data from August 2000 aerial surveys of the PWS trend count route, prepare a final analysis of PWS trend count data since 1989, and prepare a manuscript for publication.
2. Conduct final analysis of data from seven harbor seal pups that were satellite tagged in June-July 1999, integrate tagging data from 1999 seal pups with data from previous years, and prepare data for publication in the peer-reviewed literature.
3. Prepare manuscript on spatial and temporal scales of diet and foraging patterns of PWS harbor seals based on fatty acids signature analysis.

B. Methods

Data will be analyzed and manuscripts prepared by the investigators who were primarily responsible for the research. Responsibilities will be as follows: a) aerial surveys – Frost and Ver Hoef; b) movements and hauling out behavior – Lowry; c) diving behavior – Frost; d) fatty acids analysis – Iverson and Frost.

C. Contracts and Other Agency Assistance

Fatty acid and D₂O analyses, interpretation and manuscript preparation will be done by Dr. Sara Iverson at Dalhousie University under an existing Cooperative Agreement between ADF&G and Dalhousie. Dr. Iverson has conducted all previous fatty acid signature analyses and body composition work for PWS harbor seal studies.

Lloyd Lowry at the University of Alaska Fairbanks will conduct final analysis and manuscript preparation for data regarding movements and hauling out behavior of harbor seal pups through a Reimbursable Services Agreement with UAF. Mr. Lowry has analyzed all previous PWS tagging data and has been involved in the project since its inception..

SCHEDULE

A. Measurable Project Tasks for FY 00 (October 1, 2000 - September 30, 2001)

FY 01: October 1, 2000- September 30, 2001

October – December:	Analysis of aerial survey data
October – December	Preparation of manuscript on spatial and temporal scales of foraging of PWS harbor seals
October-December	Analysis of 1999 satellite tag data for PWS harbor seal pups, and preparation of manuscript on movements and hauling out behavior.
January (3-4 days)	Attend Annual Restoration Workshop
January – March	Preparation of manuscript about harbor seal trends in PWS
January – March	Preparation of manuscript on diving behavior of PWS harbor seal pups.

B. Project Milestones and Endpoints

December 2000:	Submit manuscript on spatial and temporal scaled of foraging of PWS harbor seals
December 2000:	Submit manuscript on movements and hauling out behavior of PWS harbor seal pups
March 2001:	Submit manuscript on recent harbor seals trends in PWS
March 2001:	Submit manuscript on diving behavior of PWS harbor seal pups.

C. Completion Date

This project will include one fiscal year, FY 01, and will be completed by September 30, 2001.

PUBLICATIONS AND REPORTS

- 1) Iverson, S. J., Frost, K. J. and Lowry, L. F. Spatial and temporal scales of diet and foraging patterns of harbor seals in Prince William Sound, Alaska. *Ecological Applications*. (This may be split into two manuscripts.)
- 2) Frost, K. F, Lowry, L. F., and Ver Hoef, J. M. Trends in harbor seal abundance in Prince William Sound, Alaska, based on molting-period counts during 1984-2000. *Marine Mammal Science*.
- 3) Lowry, L. F., Frost, K. J., and Ver Hoef, J. M. Movements of satellite-tagged harbor seal pups in Prince William Sound, Alaska, 1997-2000. *Marine Mammal Science*.
- 4) Frost, K. J., Simpkins, M. A., and Lowry L. F. Diving behavior of harbor seal pups in Prince William Sound, Alaska, 1997-2000. *Marine Mammal Science*.

PROFESSIONAL CONFERENCES

None anticipated in 2000-2001

NORMAL AGENCY MANAGEMENT

This project is funded entirely by the Trustee Council as a restoration project. ADF&G has no management responsibility for harbor seals. ADF&G biologists are conducting this research as principal investigators because of their many years of experience investigating the biology of seals and other marine mammals in Alaska.

ADF&G is conducting studies of harbor seals in southeast Alaska and near Kodiak with funding from NOAA/NMFS. Those studies contain similar components to the PWS study and are closely coordinated to ensure that data are collected and analyzed in a similar manner. This will facilitate comparisons of data. It is anticipated that joint publications will be prepared comparing various aspects of harbor seal behavior in PWS and other parts of Alaska.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

ADF&G receives funding from NOAA to conduct complementary studies of harbor seals in the northern GOA and southeast AK. Results of those studies and PWS studies are compared, and in the future will be included in joint, comparative publications.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This project is a follow-up to Project 064, which will allow final analysis and reporting of data collected too late in the year to be completed by September 30, 2000. This includes data from

August 2000 aerial surveys and from satellite tags attached to pups in June/July 1999 that were still transmitting in late spring 2000.

PROPOSED PRINCIPAL INVESTIGATOR

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PERSONNEL QUALIFICATIONS

Kathryn Frost (the principal investigator) has conducted research on marine mammals in Alaska since 1975. She has undertaken extensive research on natural history and ecology of seals, including aerial surveys; studies of food habits and trophic interactions; and studies of habitat use using satellite tags. She has conducted extensive aerial surveys of harbor seals in PWS and boat-based observations and sampling of harbor seals as part of NRDA studies following the EVOS. She has conducted satellite tagging studies of harbor seals in PWS from 1991 through 1999.

Lloyd Lowry is an Affiliate Associate Professor of Marine Science at the School of Fisheries and Ocean Sciences, University of Alaska Fairbanks. He has conducted research on marine mammals in Alaska since 1975, including studies of the natural history, ecology, distribution, abundance, and food habits of seals. He has participated in all NRDA and Restoration studies on harbor seals, including the development of methods to catch and attach satellite tags to harbor seals. He has been responsible for project coordination and management of state and federally funded research projects, and is familiar with the federal marine mammal permit system.

Dr. Sara Iverson is an Assistant Professor at the University of Dalhousie. She is currently conducting research at Sable Island, Nova Scotia, on the lipid metabolism of seals and the use of fatty acids to determine marine food webs. She received her Ph.D. in nutritional sciences, conducting studies of the energetics of reproduction and fatty acid metabolism in seals. She developed procedures for analysis of lipids in milk, blubber and tissues of pinnipeds. Dr. Iverson has published extensively on those subjects.

Dr. Jay Ver Hoef is a Biometrician for ADF&G. He has been responsible for statistical analysis of all harbor seal data during NRDA and Restoration studies. He has participated in field work in PWS and is familiar with seal catching and tagging techniques.

KEY PERSONNEL

Kathryn Frost:	Project management and coordination, data analysis, reporting
Lloyd Lowry:	Data analysis and reporting
Jay Ver Hoef:	Statistical analysis of data, reporting
Sara Iverson:	Fatty acid and body composition analysis, interpretation and reporting

LITERATURE CITED

- Frost, K. J., L. F. Lowry, E. Sinclair, J. Ver Hoef, and D. C. McAllister. 1994. Impacts on distribution, abundance, and productivity of harbor seals. Pages 97-118 *in*: T. R. Loughlin (ed.). *Marine Mammals and the Exxon Valdez*. Academic Press, San Diego, CA.
- Frost, K. F., L. F. Lowry, and J. Ver Hoef. 1995. Habitat use, behavior, and monitoring of harbor seals in Prince William Sound, Alaska. Ann. Rep. to the EVOS Trustee Council. Restoration Study No. 94064 and 94320-F. 88 pp.
- Frost, K. F., L. F. Lowry, R. J. Small, and S. J. Iverson. 1996. Monitoring, habitat use, and trophic interactions of harbor seals in Prince William Sound, Alaska. Ann. Rep. to the EVOS Trustee Council. Restoration Study No. 95064. 133 pp.
- Frost, K. F., L. F. Lowry, J. M. Ver Hoef, and S. J. Iverson. 1997. Monitoring, habitat use, and trophic interactions of harbor seals in Prince William Sound, Alaska. Ann. Rep. to the EVOS Trustee Council. Restoration Study No. 96064. 115 pp.
- Frost, K. F., L. F. Lowry, J. M. Ver Hoef, S. J. Iverson, and T. Gotthardt. 1998. Monitoring, habitat use, and trophic interactions of harbor seals in Prince William Sound, Alaska. Ann. Rep. to the EVOS Trustee Council. Restoration Study No. 97064. 148 pp.
- Frost, K. F., L. F. Lowry, J. M. Ver Hoef, and S. J. Iverson. 1999a. Monitoring, habitat use, and trophic interactions of harbor seals in Prince William Sound, Alaska. Ann. Rep. to the EVOS Trustee Council. Restoration Study No. 98064. 145 pp.
- Frost, K. J., L. F. Lowry, and J. Ver Hoef. 1999b. Monitoring the trend of harbor seals in Prince William Sound, Alaska after the *Exxon Valdez* oil spill. *Marine Mammal Science* 15(2): 494-506.
- Iverson, S. J., K. J. Frost, and L. F. Lowry. 1997. Fatty acids signatures reveal fine scale structure of foraging distribution of harbor seals and their prey in Prince William Sound, Alaska. *Mar. Ecol. Prog. Series* 151:255-271.
- Lowry, L. F., K. J. Frost, and K. W. Pitcher. 1994b. Observations of oiling of harbor seals in Prince William Sound. Pages 209-225 *in*: T. R. Loughlin (ed.). *Marine Mammals and the Exxon Valdez*. Academic Press, San Diego, CA.
- Spraker, T. R., L. F. Lowry, and K. J. Frost. 1994. Gross necropsy and histopathological lesions found in harbor seals. Pages 281-311 *in*: T. R. Loughlin (ed.). *Marine Mammals and the Exxon Valdez*. Academic Press, San Diego, CA.
- Ver Hoef, J. M., and K. J. Frost. 1999. Bayesian hierarchical models for estimating harbor seal trends in Prince William Sound, Alaska. Pages 104-125 *in*: Monitoring, habitat use, and trophic interactions of harbor seals in Prince William Sound, Alaska. Ann. Rep. to the EVOS Trustee Council. Restoration Study No. 98064. ADF&G, Fairbanks, AK.

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001				
Personnel		\$13.0				
Travel		\$0.5				
Contractual		\$8.8				
Commodities		\$0.0				
Equipment		\$0.0	LONG RANGE FUNDING REQUIREMENTS			
Subtotal	\$0.0	\$22.3				Estimated FY 2002
General Administration		\$2.6				
Project Total	\$0.0	\$24.9				\$0.0
Full-time Equivalentents (FTE)		0.2				
Dollar amounts are shown in thousands of dollars.						
Other Resources						
<p>Comments:</p> <p>This proposal is to conduct final analysis and manuscript preparation for aerial surveys conducted in August 2000, and satellite tags attached in June/July 1999 that were still transmitting in late spring 2000. There is not sufficient time between final data acquisition and the end of the FY 00 contract year to complete these tasks. The proposal covers the final analysis of data and the preparation of 4 manuscripts. These include 1) final trend analysis for harbor seals in PWS; 2) diving behavior of harbor seal pups in PWS, 1997-2000; 3) movements and hauling out of harbor seal pups in PWS, 1997-2000; and 4) spatial and temporal scales of diet and foraging of PWS harbor seals.</p> <p>None of the costs identified in this budget are for NEPA compliance. Costs for meeting attendance are included under travel, and total \$0.7 K. This includes attendance at the annual EVOS workshop.</p>						

FY01

Prepared: 3 April 2000

Project Number: 01064
 Project Title: Manuscript Preparation - PWS Harbor Seal Studies
 Agency: Alaska Department of Fish and Game

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	
Description	
Page charges (Marine Mammal Science, 2 manuscripts @ 14 pp each at \$15/page RSA with UAF for L. Lowry	
When a non-trustee organization is used, the form 4A is required.	Contractual Total
Commodities Costs:	
Description	
	Commodities Total

FY01

Prepared:3 April 2000

Project Number: 01064
 Project Title: Manuscript Preparation - PWS Harbor Seal
 Studies
 Agency: Alaska Department of Fish and Game

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

New Equipment Purchases:		Number of Units	Unit Price	
Description				
	none			
Those purchases associated with replacement equipment should be indicated by placement of an R.			New Equipment Total	
Existing Equipment Usage:		Number of Units		
Description				

FY01

Project Number: 01064
 Project Title: Manuscript Preparation - PWS Harbor Seal Studies
 Agency: Alaska Department of Fish and Game

Prepared:3 April 2000