

-

•

-.

00290

# **Project** Title: Hydrocarbon Data Analysis, Interpretation, and Database Maintenance for Restoration and NRDA Environmental Samples Associated with the *Exxon Valdez* Oil Spill

Project Number:	00290	
Restoration Category:	Service Project	
Proposer:	Bonita D. Nelson and Jeffrey W NMFS, Auke Bay Laboratory ABL Program Manager: Dr. Sta NOAA Program Manager: Bruc	V. Short in Rice se Wright
Lead Trustee Agency:	NOAA	
Cooperating Agencies:	None	
Alaska SeaLife Center:	No	RECEIVED
Duration:	Service Ongoing	APR 1 5 1999
Cost FY 00:	59.3	EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
Cost FY 01:	35.0	
Cost FY 02:	35.0	
Geographic Area:	Not Applicable	
Injured Resource/Service:	Maintenance of the Trustee hyd environmental samples, interpre	rocarbon database, archival of tative services

## ABSTRACT

This project is a continuation of the NRDA and Restoration database management, sample storage, and interpretive service. New data will continue to be incorporated into the Trustee hydrocarbon database. Updated summary report for investigators and managers will be produced along with an electronic copy of the data for all data queries. A database for pristane sample collection and analysis information will be maintained and a database will be initialed for fatty acid/lipid class composition sample collection and analysis for ABL Trustee funded projects.

## INTRODUCTION

The Auke Bay Laboratory provides data and sample archiving services for all samples collected for hydrocarbon analysis in support of *Exxon Valdez* Trustee Council projects. These data represent samples collected since the oil spill in 1989 to the present and include environmental and laboratory Response and Restoration data . Additionally, we provide interpretive services for the hydrocarbon analyses. Currently, the database contains results of the hydrocarbon analysis of more than 13,000 samples and collection information from more than 47,000 sediments, tissues, water, or oil samples. The primary purpose of this project is to maintain the integrity of the database, incorporate new data and continue hydrocarbon data interpretive services. This year we are proposing to continue the task of maintaining a pristane database and generate a fatty acid/lipid class database for Trustee funded projects at the Auke Bay Laboratory. The second purpose is to make the results of the hydrocarbon analyses available to principal investigators, resources managers and to the public. This service is expected to have activity through synthesis period of the next one year. The third purpose of this project is to maintain the integrity of archived samples in freezers many of which have not yet been analyzed for hydrocarbons.

The Trustee hydrocarbon database not only contains sample collection and hydrocarbon analyses information, but also has data concerning sample shipping and location information as well as lists of other database identifiers (such as species and location codes). A public version of this database containing the sample collection and environmental hydrocarbon sample analyses was released in 1996 (*Exxon Valdez* Oil Spill of 1989: State/Federal Trustee Council Hydrocarbon Database 1989-1995 -EVTHD). Updating the database is an on-going program, samples from Chenega cleanup (98291) final analysis (98291) were added in 1998 and samples collected from from mussel beds are projected to be added in 1999 as well as any other samples collected from Trustee projects submitted for FY2000.

The hydrocarbon interpretive service is designed specifically for investigators and managers. This includes: (1) identification of the probable sources of the hydrocarbons observed in the samples, (2) evaluation of new hydrocarbon data for evidence of systematic bias, (3) hydrocarbon data editing according to consistent criteria. Recently interpretation has grown to include identification of potential hydrocarbon sources (e.g. coal) for the background hydrocarbon signal in PWS. This is a continuation of project 98290 and previously funded under TS#1, 93090, 94290, 95290, 96290, 97290,98290 and 99290.

#### **NEED FOR THE PROJECT**

#### A. Statement of Problem

The Trustee hydrocarbon database is a dynamic structure which requires updating and maintenance. Currently, the database contains an inventory of the Trustee hydrocarbon sample collection and provides for retrieval of hydrocarbon analyses by principal investigators and managers. This project is designed to provide easy access to the Trustee hydrocarbon database and ensure the accuracy of the data. The volume of data contained in the database suggests that other users will benefit from access, particularly as more data is added (Chenega project; oiled mussel bed project, and pink salmon) and as more synthesis products are produced (salmon and herring).

#### **B.** Rationale/Link to Restoration

Archiving of the Trustee hydrocarbon sample data will ensure that these data are available to principal investigators, government agencies, and the interested public on a timely basis. The database allows direct comparison of restoration and NRDA data, and contains an inventory of hydrocarbon samples and information about their collection, storage and analysis. The continued use of the methods for hydrocarbon data evaluation and interpretation developed for the *Exxon Valdez* NRDA samples will insure direct comparability of future with previous samples. This will substantially increase the probability that temporal trends in these data will be detected when actually present. Principal investigators will be able to get assistance with chemical interpretation of hydrocarbon results from their project or other projects that relate to their project when needed. Since most investigators are not chemists, this type of assistance is usually required for proper interpretation of hydrocarbon results. Application of the petroleum weathering model developed under this project (Short and Heintz, 1997) has been used to compare coal samples and Katalla seep with Prince William Sound background samples, and has identified coal as the "biologically non-available source, in contrast to researchers sponsored by EXXON, who have identified the source as Katalla seep oil.

#### C. Location

While this project resides at the Auke Bay Laboratory, Juneau, Alaska, the service provided serves the entire spill area.

#### COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Community involvement includes and extends beyond the spill area. Science centers, public schools, native corporations, universities, environmental organizations and other concerned groups will have access to the database with guidelines on how the data can be used.

### **PROJECT DESIGN**

#### A. Objectives

1. Continue maintenance of the Trustee hydrocarbon database by updating the database with new information and continue the sample archiving procedures developed under NRDA.

 Continue interpretation of hydrocarbon data, including new data produced for principal investigators and resources managers and for syntheses products as needed.
Maintain Pristane database for Trustee funded projects as well as maintains a Fatty Acid/Lipid Class Composition Database for Trustee funded projects located at Auke Bay Laboratory.

4. Provide a new software product for the publicly accessible database which includes

hydrocarbon samples analyzed through 1999.

5. Extend the use of the petroleum weathering model by using it as a tool for identifying potential sources of petroleum that contribute to the background signal identified in Constantine Harbor.

6. Design a long-term archiving plan for the Trustee hydrocarbon database PWSOIL.

## B. Methods

Data associated with hydrocarbon samples are added to the existing Trustee hydrocarbon database. The samples and data currently reside at the Auke Bay Laboratory of NMFS. Incoming samples are inventoried and stored in laboratory freezers, and sample collection information is entered into the database. Samples are released for hydrocarbon analysis after ABL receives a written request from the responsible project leader. Hydrocarbon data, reported by the analytical laboratory, are matched to the sample collection information and all the data are checked for errors and electronic copies are sent to principal investigators or other requesters. An updated version of the public release of the database will be developed in Visual Basic software using *Exxon Valdez* Oil Spill of 1989: State/Federal Trustee Council Hydrocarbon Database 1989-1995 (EVTHD) as a template and will include data collected from Trustee funded projects including sampling and analytical quality control procedures .

The petroleum weathering model developed under this project has been used to reject the hypothesis that the hydrocarbons comprising the background PAH source are derived from the Katalla oil seep. Analysis of sediment and mussel samples collected from locations near the Katalla oil seep as well as coal deposits east of PWS supports the conclusion that PAH derived from coal characterize the background hydrocarbon signal (Short et al., 1999). We will continue to use this information and analyses when necessary to demonstrate the generality of the weathering model with other oil sources and the absence of a similar weathering process in coal.

The Auke Bay Laboratory will continue to keep all environmental samples collected for hydrocarbon analysis under all phases of the oil spill process frozen in locked storage.

The pristane database will be maintained in ACCESS software. Information from samples collected under Trustee project 195 will be combined with data from the Trustee hydrocarbon database where applicable to provide a complete data set of pristane related information.

The fatty acid/lipid class database will be generated in current database software.

## C. Contracts and Other Agency Assistance

No contracts are anticipated<sup>2</sup>

### SCHEDULE

### A. Measurable Project Tasks for FY00

Samples will be stored and data analyzed throughout fiscal year. Release of the updated public version of the database software: Exxon Valdez Oil Spill of 1989: State/Federal Trustee Council Hydrocarbon Database 1989-1995.

## **B. Project Milestones and Endpoints**

April 15: Annual report in the form of updated release of hydrocarbon data software.

The primary objective of this project is to provide an ongoing service, consequently there are few set milestone dates or endpoints.

### C. Completion Date

This is an ongoing service project to be completed when samples are no longer collected for hydrocarbon analysis and the Trustee Council terminates this service.

## PUBLICATIONS AND REPORTS

The public release of the hydrocarbon database for projects funded in FY98 will be available 15 April, 1999 in the form of the annual report.

### **PROFESSIONAL CONFERENCES**

One meeting is required, an annual Quality Assurance Control meeting attended by ABL's Senior Analytical Chemist. The results of an international calibration exercise by participant is reviewed for the integrity and credibility of chemical analyses. This meeting usually occurs in the Washington D.C. area, and is sponsored by National Institute of Standards and Technology (NIST).

### NORMAL AGENCY MANAGEMENT

NOAA/NMFS has statutory stewardship for most living marine resources; however, if the oil spill had not occurred, NOAA would not be conducting this project. NOAA/NMFS proposes to make a significant contribution (as stated in the proposed budget) to the operation of this project, making it truly cooperative.

## **COORDINATION AND INTEGRATION OF RESTORATION EFFORT**

This project is a continuation of NRDA database and chemical interpretation work.

## **EXPLANATION OF CHANGES IN CONTINUING PROJECTS**

This ongoing service project has no significant project design or schedule differences from the

project funded in FY98, it is a continuation of the same service. The project has been downsized, as the input volume has decreased somewhat, although interpretation services will probably increase.

#### PROPOSED PRINCIPAL INVESTIGATOR

Bonita D. Nelson NMFS Auke Bay Laboratory 11305 Glacier Highway Juneau, Alaska 99801 907-789-6071 907-789-6094 bonita.nelson@noaa.gov

### PRINCIPAL INVESTIGATORS

Bonita D. Nelson

Education: BS 1979, University of Illinois, Urbana (Ecology, Ethology, Evolution) MS 1986, University of Alaska-Juneau (Fisheries)

Other Revelant Experience:

Database manager of the Trustee hydrocarbon data for 4 years. Responsibilities include: supervision of data entry of sample and analytical data; processing and dissemination of data after interpretation by chemist; database management including data retrieval for production of the public versions of the database. Nelson has designed and managed databases as well as analyzed data for the radio telemetry program at the Auke Bay Laboratory for 10 years.

Jeffrey W. Short

Education: BS, 1972 University of California, Riverside (Biochemisty & Philosophy) MS, 1982, University of California, Santa Cruz (Physical Chemistry)

Other Experience:

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

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

1991 - 1992 : Principal Investigator, Exxon Valdez project Subtitle #8 ; Development of computer-based statistical methods for global examination of sediment and mussel hydrocarbon data produced for the Exxon Valdez NRDA effort for systematic bias, and for identification of

probable sources of hydrocarbons. In addition, this project produced both hard-copy and computer display maps of all the sediment and mussel hydrocarbon data.

#### LITERATURE CITED

- Short, J. W., K.A. Kvenvolden, P.R. Carlson, F. D. Hostettler, R. J. Rosenbauer, & B. A. Wright, 1999. Natural Hydrocarbon Background in Benthic Sediments of Prince Willaim Sound, Alaska: Oil vs Coal. Environ. Sci. Technol. 33:34-42.
- Short, J. W., and R. A. Heintz. 1997. Identification of *Exxon Valdez* oil in sediments and tissues from Prince William Sound and the Northwestern Gulf of Alaska based on a PAH weathering model. Environ. Sci. Technol. 31:2375-2384.

#### 2000 EXXON VALDEZ TRI COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

\_\_\_\_

Ē

Budget Category:		TToposeu	
	FY 1999	FY 2000	
)	<b>6444</b>	¢44.7	
	\$44.4	\$44.7 \$2.2	en 1997 - Maria Maria Managara, ang kanalang kanalang kanalang kanalang kanalang kanalang kanalang kanalang kanal 1997 - Maria Managara, kanalang kanalang kanalang kanalang kanalang kanalang kanalang kanalang kanalang kanalan
ravel	\$4.2 \$1.5	\$3.3 \$1.5	
	\$1.5	\$1.5	1999년 1월 1978년 1월 1979년 1월 1981년 1월 1971년 1월 19 1971년 1월 1971년 1월 197
commodities	\$2.0		
quipment		\$0.0	LONG RANGE FUNDING REQUIREMENTS
Subtotal	\$52.1	\$52.5	Estimated Estimated
ieneral Administration	\$6.8	\$6.8	FY 2001 FY 2002
Project Total	\$58.9	\$59.3	\$35.0 \$35.0
			· 경험·영상·영상· 영상· 영상· 영상· 영상· 영상· 영상· 영상· 영상·
ull-time Equivalents (FTE)	0.6	0.6	
		D	ollar amounts are shown in thousands of dollars.
)ther Resources	\$20.9	\$20.9	
NOAA Contribution: Habitat Senior Research Chemist, month @6.7K, for a total of 20.9	J Short 1.0 m IK	o.@ 9.4 K, Fish	ery Biologist J. Maselko 1.0 mo @ 4.8 K, Senior Analytical Chemist, M. Larsen 1.0

٠

.

#### 2000 EXXON VALDEZ TRI COUNCIL PROJECT BUDGET

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	_FY 2000
Bonita Nelson	Fisheries Biologist/Database Manager	11/3	6.0	6.1		36.6
Marie Larsen	Senior Analytical Chemist	11/6	0.5	6.7		3.4
Jeff Short	Senior Research Chemist	13/4	0.5	9.4		4.7
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		7.0	22.2	0.0	
				Pers	onnel Total	\$44.7
Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 2000
Anchorage Workshop		0.4	2	3	0.2	1.4
(Miscellaneous - ca	ar rental, telephone, POV mileage etc)					0.0
		1				0.0
Quality Assurance/Qua	lity Control Annual Meeting, 1 senior chemis	1.5	1	2	0.2	1.9
national Institute fo	or Standards and Technology					0.0
		ł				0.0
		1				0.0
						0.0
						0.0
						0.0
		ł				0.0
						0.0
				-	<b>Fravel Total</b>	\$3.3

October 1, 1999 - September 30, 2000

<b>FY00</b> Project Number: 00290 Project Title: The Hydrocarbon Database and Agency: National Oceanic and Atmospheric Ad	Interpretation & Travel dministration DETAIL
--	--

٦

Г

C

、

,

#### 2000 EXXON VALDEZ TRI **COUNCIL PROJECT BUDGET**

October 1, 1999 - September 30, 2000

<b>Contractual Costs:</b>			Proposed
Description			FY 2000
Disposall of Archival S	Samples (classified as hazardous materials)		1.5
When a non-trustee or	ganization is used, the form 4A is required.	<b>Contractual Total</b>	\$1.5
<b>Commodities Costs:</b>			Proposed
Description			FY 2000
Production of updated	public information of chemical data (lipids, hydrocarbon or pristane)		2.0
		Commodities Total	\$3.0
FY00	Project Number: 00290 Project Title: The Hydrocarbon Database and Interpretation Agency: National Oceanic and Atmospheric Administration	F Coi Co	ORM 3B ntractual & mmodities DETAIL

Prepared:4/8/99

Υ.

.

,

#### 2000 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2000
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of a	an <b>New Equi</b>	oment Total	\$0.0
Existing Equipment Usage:		Number	Inventory
Description		of Units	Agency
<b>FY00</b> Project Number: 00290 Project Title: The Hydrocarbon Database and Interpretation Agency: National Oceanic and Atmospheric Administration		E	FORM 3B Equipment DETAIL

Prepared:4/8/99

¢

.

2

-

00306

· · ·

# Ecology and Demographics of Pacific Sand Lance, Ammodytes hexapterus Pallas, in Lower Cook Inlet, Alaska

Project Number:	00306	
Restoration Category:	Research	
Proposer:	USGS Biological Resources Div	vision
Lead Trustee Agency:	DOI	
Cooperative Agencies:	ADF&G, AMNMR, NMFS (not	t funded)
Alaska SeaLife Center	no	
Duration:	4 <sup>th</sup> year, 4 year project	
Cost FY 00:	\$20,000	RECEIVED
Geographic Area:	Cook Inlet, Gulf of Alaska	APR 1 5 1999
Injured Resource:	Multiple (forage fish)	EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL

#### ABSTRACT

The purpose of this study is to characterize the basic ecology, distribution, and demographics of sand lance in the Gulf of Alaska. Recent declines of upper trophic level species in the Northern Gulf of Alaska have been linked to decreasing availability of forage fishes. Sand lance is the most important forage fish in most nearshore areas of the northern Gulf. Despite its importance to commercial fish, seabirds, and marine mammals, little is known or published on the basic biology of this key prey species. In this final year of the project we will focus on finishing reports and submitting publications to peer-reviewed journals.

8

#### INTRODUCTION

An estimated 250,000 seabirds were killed by *Exxon Valdez* oil pollution. Based on comparisons of pre-spill (1970s) and post-spill (1989-1995) data, long-term effects on seabirds attributed to oil pollution included: i) population declines, ii) reduced breeding success, and, iii) delayed breeding phenology. However, some purported effects of the spill may have been due in large part to natural changes in the Gulf of Alaska marine ecosystem-- in particular, declines in forage fish abundance (Piatt and Anderson 1996). The rate at which seabird populations will recover from effects of oil mortality are unknown, but is probably linked to population dynamics of forage fish species, of which sand lance is the most important.

Sand lance (genus *Ammodytes*) are zooplanktivorous, semi-demersal, schooling perciforms. They are ubiquitous to the boreo-arctic regions of the North Atlantic and North Pacific and are particularly abundant in coastal regions. There are three genera of sand lance; Hyperoplus, Gymnammodytes, and Ammodytes. Ammodytes is distributed in the Northwestern Atlantic from West Greenland to Cape Hatteras, North Carolina (Leim and Scott 1966, Winters and Dalley 1988) and in the North Pacific from the Bering Sea to southern California (Wilimovsky et al. 1988). Although several species of *Ammodytes* have been described for the North Atlantic and at least two in the North Pacific, *Ammodytes hexapterus* is the only species currently described in the Gulf of Alaska.

Sand lance serve as an important trophic link between zooplankton and marine vertebrate piscivores (Winters 1983) particularly in continental shelf ecosystems (Springer *et al.* 1996). In the North Pacific, sandlance are forage for fish, seabirds, and marine mammals. Seabirds consuming sand lance include red-faced cormorant (Hunt et al. 1981), black-legged kittiwake, common murre, thick-billed murre, pigeon guillemot, horned puffin, tufted puffin, brachyramphus murrelets, and rhinoceros auklet (Wilimovsky *et al.* 1988, Springer 1991, Piatt and Anderson 1996). Marine mammals consuming sand lance include Stellar sea lion, minke, sei, and humpback whales (Wilimovsky et al. 1988). Commercially important fish preying on sand lance include Pacific cod, halibut, lingcod, rockfish, and salmon (Wilimovsky et al. 1988).

Due to commercial fisheries for sand lance in the North Sea and around Japan, much is known about sand lance in these regions. In the North Pacific, however, sand lance are of little commercial importance. Despite their role as a forage species, there is a paucity of published information on their biology and population dynamics in this area.

#### NEED FOR THE PROJECT

#### A. Statement of Problem

Lack of recovery of species injured in the *Exxon Valdez* oil spill is currently thought to be linked to changes in forage fish abundance or composition. Changes in species composition or abundance of forage fish will have marked effects on predators, in terms of the time needed to

Prepared April 10, 1999

Project 00306

find and consume fish, as well as in the relative energy value of that fish once consumed. Therefore, an understanding of the factors affecting forage fish distribution, abundance, and quality is vital to an understanding of predator distribution, abundance and recovery.

#### B. Rationale

It is important to study the ecology and demographics of sand lance because i) sand lance are one of the most important prey species consumed by seabirds, marine mammals, and commercial fish in Alaska; ii) changes in sand lance abundance and distribution therefore have direct effects on predators; and, iii) natural environmental changes may have reduced sand lance populations in recent years. These population changes may limit the ability of higher predators to recover from oil spill impacts. In this final year of the project we will focus on writing a final report and submitting manuscripts for publication in peer-reviewed journals.

#### C. Location

The project is a portion of an ecosystem study of lower Cook Inlet (EVOS APEX project 00163m). In this final phase of the project, no field work is planned. Data analysis and report writing will take place in Anchorage at USGS offices.

#### COMMUNITY INVOLVEMENT

None for final phase of project.

#### **PROJECT DESIGN**

#### A. Objectives

- 1. To establish how seasonal and diel movements of sand lance impact their availability as a food source for marine piscivores.
- 2. Measure demographic parameters of sand lance including age composition, growth rate, patterns of growth, and sex ratios and compare between regions.
- 3. Characterize critical burrowing and spawning habitat of sand lance will be described in relation to physical parameters (e.g., temperature, substrate type, salinity, and turbidity). Physiological adaptations will also be explored in relation to their habitat.
- 4. Sand lance early life history and decadal scale changes will be investigated using a 20 year historical database provided by Paul Anderson.
- 5. Seabird diet data (tufted puffin, horned puffin, rhinoceros auklet) will be used to help establish sand lance distribution and growth within the Gulf of Alaska. These data are

Prepared April 10, 1999

Project 00306

also expected to provide insight into critical environmental parameters needed for optimal sand lance habitat.

## B. Methods

No field work is planned for this final year. Methods for field work have been described in previous proposals. Reports and papers are being written that will address the objectives described above.

## C. Contracts and Other Agency Assistance

A contract will be used to fund Martin Robards to complete products in this final phase of the project.

### SCHEDULE

## A. Measurable Project Tasks for FY 00

- 1. M.Sc. thesis will be submitted to fulfill requirements for graduation from Memorial University of Newfoundland.
- 2. Report on sand lance energetics will be published.
- 3. Report on sand lance growth and otolith development will be published.
- 4. Review of sand lance biology will be published.
- 4. Collaborative work to compare sand lance habitat in Kachemak Bay with that in Prince William Sound will be completed and submitted for publication.
- 5. Historical database of larval sand lance will be analyzed and a manuscript prepared for publication.
- 6. Final fishing dataset from Lower Cook Inlet (5 years data) will be analyzed for annual variation in sand lance distribution and habitat preferences. A manuscript will be prepared for publication.

## B. Project Milestones and Endpoints

FY 00 is the final year of this project. All data will be finalized and manuscripts submitted for publication.

#### C. Completion Date

Field work for this project will be completed in the summer of 99. Compilation and analysis of all data and production of a final report will be finalized in FY00.

#### **PUBLICATIONS AND REPORTS**

These are broken down here into categories. Some papers are completed and in press, and minor final editing will take place in FY99. Other papers are submitted and/or under revision, and since we are now entering the field season, it is likely that revisions and final editing of proofs will take place in FY00. Finally, some papers are in preparation or planned, and most of this will take place in FY00.

#### NO WORK REQUIRED IN FY00

- Robards, M.D., J. F. Piatt, and G.A. Rose. 1999. Maturation, Fecundity, and Intertidal Spawning of Pacific Sand Lance (*Ammodytes hexapterus*) in the Northern Gulf of Alaska. Journal of Fish Biology 54: *In Press*.
- Robards, M., J.F. Piatt, A. Kettle, and A. Abookire. 1999. Temporal and geographic variation in fish populations in nearshore and shelf areas of lower Cook Inlet, Alaska. Fishery Bulletin. *In Press.*
- SOME WORK WILL BE REQUIRED IN FY00
- Robards, M.R., and J.F. Piatt. 1999. Biology of the Genus Ammodytes The Sand Lances. U.S. Forest Service Technical Report Series. Accepted, under revision.
- Willson, M.F., R.H. Armstrong, M.D. Robards, and J.F. Piatt. 1999. Sand lance as cornerstone species for predator populations. U.S. Forest Service Technical Report Series. *Accepted*, *under revision*.
- Willson, M.F., R.H. Armstrong, M.D. Robards, and J.F. Piatt. 1999. An annotated bibliography of sand lance. U.S. Forest Service Technical Report Series. *Accepted, under revision*.
- Robards, M.D., J.A. Anthony, G.A. Rose, and J.F. Piatt. 1999. Changes in proximate composition and somatic energy content for Pacific sand lance (*Ammodytes hexapterus*) relative to maturity, season, and location. Journal of Experimental Marine Biology and Ecology. *Submitted*.
- Robards, M.D., G.A. Rose, and J.F. Piatt. 1999. Somatic growth and otolith development of Pacific sand lance (*Ammodytes hexapterus*) under different oceanographic regimes. Mss. under final revision for submission to Fisheries Oceanography.

Prepared April 10, 1999

Project 00306

- Litzow, M.A., J.F. Piatt, A.A. Abookire, A.K. Prichard and M.D. Robards. 1999. Pigeon Guillemot Nestling Diets as Monitors of Nearshore Fish Communities. Mss. under final review for submission to Marine Ecology Progress Series.
- Abookire, A.A., J.F. Piatt and M. Robards. 1999. Stratification and small-scale thermohaline differences influence nearshore fish distributions in an Alaskan estuary. Mss. under final revision for submission to Estuarine, Coastal and Shelf Science.
- Robards, M.D. 1999. Ecology and Demographics of Pacific Sand Lance, *Ammodytes hexapterus* Pallas, in Alaska. M.Sc. Thesis, Memorial University of Newfoundland.
- MOST OR ALL WRITING WILL TAKE PLACE IN FY00
- Robards, M.D., J.F. Piatt, and G.A. Rose. 2000. Ecology and Demographics of Pacific Sand Lance, *Ammodytes hexapterus* Pallas, in lower Cook Inlet, Alaska. Exxon Valdez Oil Spill Trustee Council Restoration Project 00306 Final Report.
- Robards, M.D., W. Ostrand, and J. Piatt. 2000. Prediction of sand lance habitat using hydroacoustic bottom type assessment in Lower Cook Inlet and Prince William Sound, Alaska. Field work in FY99, and data analysis and writing in FY00
- Robards, M.D., J.F. Piatt, and P. Anderson. 2000. Decadal-scale changes in abundance of Pacific Sandlance in the Gulf of Alaska. Historical trawl data analysis and writing in FY00.
- Robards, M.D., J.F. Piatt, and S.A. Hatch. Geographic variability in sand lance growth and development in the Gulf of Alaska. Historical data on puffin diets will be analyzed and written up in FY00.
- Robards, M.D., J.F. Piatt, and A. Abookire. Temporal and spatial variability in abundance of Pacific sand lance in lower Cook Inlet, 1995-1999. Field work in FY99, and data analysis and writing in FY00.

We project that all results from this study will be fully analyzed, written and submitted to peer review journals by October 2000. Journals that we are targeting include: Marine Biology, Transactions of the American Fisheries Society, Journal of Fish Biology, Fisheries Bulletin, Fisheries Oceanography, and Experimental Marine Biology and Ecology.

#### **PROFESSIONAL CONFERENCES**

Work from this project was presented at the 1999 Pacific Seabird Group (PSG) meeting in Blaine, Washington. Further results will be presented at the PSG meeting in 2000.

Prepared April 10, 1999

Project 00306

#### NORMAL AGENCY MANAGEMENT

This work would not be conducted as part of normal USGS activities.

### COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Close coordination has, and will continue to be developed between ADF&G, UAF, NMFS, and USFWS for collections of sand lance offshore and in other areas of Alaska. Work in FY99 on sand lance will also continue to be coordinated with other APEX investigators working in Prince William Sound such as Dan Roby, Bill Ostrand, and David Irons. In FY00, coordination will consist largely of collaboration on analysis and reporting of results.

## EXPLANATION OF CHANGES IN CONTINUIING PROJECTS

This proposal differs from the FY99 proposal in that we are conducting no field work in FY00, and all efforts will be concentrated on publishing results. The proposed cost (\$20,000) is the same as indicated in previous proposals.

## PRINCIPAL INVESTIGATOR

Dr. John F. Piatt Alaska Biological Science Center Biological Resources Division USGS, 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.

Prepared April 10, 1999

Project 00306

ł

#### **PROJECT LEADER**

Martin Robards, M.Sc. candidate at Memorial University of Newfoundland, St. John's. Over ten 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

Dr. George Rose, Chair for Fisheries Conservation, School of Fisheries and Marine Technology, Memorial University of Newfoundland, St. John's. Academic advisor to Martin Robards.

#### LITERATURE CITED

Dick, M. H., and I. M. Warner. 1982. Pacific sand lance, *Ammodytes hexapterus* Pallas, in the Kodiak island group, Alaska. Syesis, 15: 43-50.

Leim, A. H. and W. B. Scott. 1966. Fishes of the Atlantic Coast of Canada. Bull. Fish. Res. Bd. Can. 155. 485pp.

Macer, C. T. 1966. Sand eels (Ammodytidae) in the southwestern North Sea: Their biology and fishery. Fishery Invest., Lond., Ser. 2, 24: 1-55.

Piatt, J. F. and P. Anderson. 1996. Response of Common Murres to the *Exxon Valdez* oil spill and long-term changes in the Gulf of Alaska marine ecosystem. In: S. D. Rice, R. B. Spies, D. A. Wolfe, and B. A. Wright (eds.). *Exxon Valdez* Oil Spill Symposium Proceedings. Am. Fish. Soc. Symp. No. 18.

Scott, J. S. 1968. Morphometrics, distribution, growth, and maturity of offshore sand lance (*Ammodytes dubius*) on the Nova Scotian Banks. J. Fish. Res. Bd. Canada, 25: 1775-1785.

Scott, J. S. 1973. Otolith structure and growth in northern sand lance, *Ammodytes dubius*, from the Scotian Shelf. ICNAF Research Bulletin, 10.

Springer, A. M. 1991. Seabird relationships to food webs and the environment: Examples from the North Pacific Ocean. In: Studies of high-latitude seabirds. I. Behavioral, energetic, and oceanographic aspects of seabird feeding ecology. W. A. Montevecchi and A. J. Gaston (eds.) Ottawa, Canada: Canadian Wildlife Service, pp. 39-48.

Springer, A. M., J. F. Piatt, and G. Van Vliet. 1996. Seabirds as proxies of marine habitats in the Western Aleutian Arc. Fisheries Oceanography 5 (1), In press.

Wilimovsky, N. J., L. S. Incze, and S. J. Westrheim. 1988. Species synopses: Life histories of selected fish and shellfish of the Northeast Pacific and Bering Sea. University of Washington. ISBN: 0-934-53905-7.

Prepared April 10, 1999

Project 00306

Winters, G. H. 1983. Analysis of the biological and demographic parameters of the northern sand lance, *Ammodytes dubius*, from the Newfoundland Grand Bank. Can. J. Fish. Aquat. Sci. 40: 409-419.

Winters, G. H. and E. L. Dalley. 1988. Meristic composition of sand lance (*Ammodytes spp.*) in Newfoundland waters with review of species designations in the Northwest Atlantic. Can. J. Fish. Aquat. Sci., 45: 516-529.

٦

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

	Authorized	Proposed						
Budget Category:	FY 1999	FY 2000						
Personnel		\$0.0						
Travel		\$0.0						
Contractual		\$18.7						
Commodities		\$0.0	2.0.0					
Equipment		\$0.0		LONG RA	ANGE FUNDIN	IG REQUIREN	MENTS	
Subtotal	\$0.0	\$18.7			Estimated	Estimated		
General Administration		\$1.3			FY 2001	FY 2002		
Project Total	\$0.0	\$20.0			\$0.0	\$0.0		]
Full-time Equivalents (FTE)		0.0						
			Dollar amounts	are shown i	n thousands of	dollars.		
Other Resources								
Comments: Close out year. C	osts for write-up	o only.						
		•						



Project Number: 00306 Project Title: Ecology and demographics of Pacific Sand Lance, Ammodytes hexapterus, Pallas, in lower Cook Inlet,. Alaska Agency: USGS (BRD) FORM 3A TRUSTEE AGENCY SUMMARY

Prepared: 4/10/99

#### 2000 EXXON VALDEZ TRI E COUNCIL PROJECT BUDGET

۰.

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly	•	Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
None		,				0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
-	Subtotal		0.0		0.0	0.0
	Subiolai		0.0	O.0	0.0 Sonnel Total	0.02
Travel Costs:		Ticket	Pound	Total	Doily	Proposed
Description		Price	Tripe	Dave	Por Diam	EV 2000
None			Thps	Days	r ei Diem	0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
				ļ		0.0
·						0.0
					<b>Travel Total</b>	\$0.0

FY00	Project Number: 00306 Project Title: Ecology and demographics of Pacific Sand Lance, Ammodytes hexapterus, Pallas, in lower Cook Inlet,. Alaska Agency: USGS (BRD)	FORM 3B Personnel & Travel DETAIL
narod:		

Prepared:



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

Contractual Costs:		Proposed
Description		FY 2000
Personal Services Contract wit	h Martin Robards to complete manuscripts	18.7
When a non-trustee organizatio	on is used, the form 4A is required.	<u>\$18.7</u>
Commodities Costs:	· · · · · · · · · · · · · · · · · · ·	Froposed
		1 2000
None		
	Commodities Total	\$0.0_
FY00	Project Number: 00306 Project Title: Ecology and demographics of Pacific Sand Lance, Ammodytes hexapterus, Pallas, in lower Cook Inlet, Alaska Agency: USGS (BRD)	FORM 3B ntractual & ommodities DETAIL
Prepared:		

3 of 8

### 2000 EXXON VALDEZ TRI E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2000
None			0.0
		]	0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
		ĺ	0.0
			0.0
			0.0
	i (		0.0
	N		0.0
I nose purchases associated with replacement equipment should be indicated by placement of an R.		ipment i otal	\$0.0
Existing Equipment Usage:	-	Number	Inventory
			Agency
·			
	:		
Project Number: 00306		_	
Project Number, 00000	0000		
<b>FY00</b>	_ance,	E	quipment
Ammodytes hexapterus, Pallas, in lower Cook Inlet,. Alask	ka		DETAIL
Agency: USGS (BRD)			]
Prepared:			1

## SOUND ECOSYSTEM ASSESSMENT (SEA): PUBLISHING THE INTEGRATED FINAL REPORTS AND A PROGRAM SYNTHESIS.

#### "Submitted Under the Broad Agency Announcement"

Project Number:	00320Z2
Restoration Category:	Research Research
Proposer: Principal Investigator:	Prince William Sound Science Center APR 1 4 1995 Jennifer Allen EXXON VALDEZ OIL SPILL
Lead Trustee Agency: Cooperating Agencies:	NOAA TRUSTEE COUNCIL ADF&G
Alaska SeaLife Center:	no
Duration:	October 1, 1999 to September 30, 2000. 2 <sup>nd</sup> year of a two-year program
Cost FY 00:	\$
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pink salmon and Pacific herring

#### ABSTRACT:

This proposal will provide coordination to print, copy and distribute the Final Report package from the EVOS TC Sound Ecosystem Assessment (SEA) project and to review, publish and distribute a SEA synthesis written for a dedicated volume of the prestigious journal, Fisheries Oceanography (Blackwell Science, Ltd). The integrated final report is a required document expected to exceed 1000 pages (some with color). The FO volume will be an externally peerreviewed scientific treatise designed to address ecosystem-level aspects of the SEA study not covered adequately by the reports of the individual projects. These products represent the closeout documentation for SEA specified in the FY99 single integrated DPD.

## INTRODUCTION

The Sound Ecosystem Assessment (SEA) program was initiated in April 1994 to evaluate possible environmental suppression of pink salmon and Pacific herring following the oil spill. The goals of SEA were to understand and model numerically the physical and biological processes that influence pink salmon and herring production in Prince William Sound (PWS). In its closeout year, FY99, the major focus of the SEA program was synthesis and subsequent report and manuscript preparation. These reports and manuscripts will be extensively reviewed and published. Since the review of its documents will not begin until mid June, 1999 (for the integrated Final Report package) and 15 September, 1999 (for the synthesis manuscripts), it is unlikely that all revisions will be completed in FY99. This proposal provides support only to complete the publication and distribution of these documents in FY00.

#### NEED FOR THE PROJECT

### A. Statement of the Problem

Successful completion of this multidisciplinary investigation requires peer authentication and publication of all Final Reports and an integrated synthesis of findings and conclusions that addresses hypotheses at the ecosystem level. Production of an integrated synthesis volume will require substantial coordination and editorial effort during and following the external review phase. This project provides services to assist the former SEA lead scientist to complete the tasks required to publish the required final reports of all projects and the Fisheries Oceanography synthesis volume for subscribers and the Trustee Council.

### B. Rationale/Link to Restoration

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

### C. Location

SEA was designed and implemented in Prince William Sound.

### COMMUNITY INVOLVEMENT

Spill-affected communities may obtain information on, and provide input to the SEA program via a dedicated web site created and maintained by the principal investigator (PI). Presentations to the Prince William Sound community are made by the PI from time to time as opportunity

prepared 10 April 99

permits. Final reports and the special synthesis volume will be available to all agencies and, by request, to users of pink salmon and herring resources in PWS and elsewhere though the Council's distribution and archival activities.

#### **PROJECT DESIGN**

#### A. Objectives

Specific project objectives are:

1. To collect, copy, bind and distribute the collection of bundled SEA final reports as required by the Trustee Council;

2. To provide coordination for review, revision and final publication of the SEA synthesis volume for the journal Fisheries Oceanography.

#### B. Methods

Receiving, copying and distributing the integrated package of approved SEA Final Reports will be accomplished at ADF&G Habitat Division, Anchorage, Alaska, by Celia Rozen and her staff. These costs are shown on the attached ADF&G portion of the this project's budget.

SEA synthesis publication activities coordinated by Dr. Allen for the journal Fisheries Oceanography will be facilitated by Dr. William Pearcy (Oregon State University, retired). Dr. Pearcy, a former EVOS TC peer reviewer, will serve as the Fisheries Oceanography guest editor for the SEA special volume. He will be responsible for externally reviewing synthesis manuscripts and for writing a preface for the publication.

Though retired after June, 1999, Dr. Ted Cooney will continue his association with SEA publication tasks and the PI, agreeing to maintain an engagement until both the Final Reports and the special journal volume are completed in 2000. Travel is requested for joint meetings of Drs. Pearcy, Cooney and Allen as needed to expedite the FO publication process.

#### C. Cooperating Agencies, Contracts and Other Agency Assistance

Project 00320Z2 will provide funding to enable coordination of synthesis and joint reporting activities among SEA scientists at the University of Alaska Fairbanks, Alaska Department of Fish and Game, Prince William Sound Science Center and USFS/Copper River Delta Institute as they address manuscript and report revisions

prepared 10 April 99

Project 00320-Z2

#### SCHEDULE

#### A. Measurable project tasks for FY00 (October 1, 1999 - September 30, 2000)

Oct. 1, 1999 - Feb. 1, 2000	Manuscript package for FO under review by Dr. Pearcy Final Reports copied and distributed by ADF&G
Nov. 1, 1999 - Feb.1, 2000	Synthesis revisions (as needed) by authors
March 1, 2000	Reviewed package sent to F.O. for publication (out of our hands)
September1, 2000	Published volume ready for distribution (out of our hands) Final publication costs paid to Blackwell Science, Ltd.

#### B. Project milestones and endpoints

The publication process detailed in this proposal will be completed when the Final Report package and FO journal volume are printed and distributed to the EVOS Trustee Council and its agencies.

#### C. Completion Date

The publication of SEA close-out documentation is expected to be concluded in FY00. The only uncertainty is the actual publication schedule for the Fisheries Oceanography special volume.

#### **PUBLICATIONS AND REPORTS**

#### **SEA Integrated Final Reports**

The approved final reports from all SEA projects will be copied and bound with a summary chapter for distribution and archival by the Trustee Council.

#### Special Volume for Fisheries Oceanography

The Fisheries Oceanography special volume of SEA results will be published by Blackwell Science Ltd. for its subscribers, with sufficient copies made to address the special needs of the Trustee Council and its agencies.

The SEA Synthesis package contains the following papers:

**Chapter 1**. Ecosystem controls of pink salmon (*Onchorynchus gorbuscha*) and Pacific herring (*Chupea pallasi*) production in Prince William Sound, Alaska. T. Cooney, et al. (the entire SEA team).

Chapter 2. Physical processes that influence the biology of Prince William Sound. S.

prepared 10 April 99

Project 00320-Z2

Vaughan, et al.

**Chapter 3.** Plankton dynamics: observed and modeled responses to physical forcing in Prince William Sound, Alaska. D. Eslinger, et al.

**Chapter 4.** Physical and ecological processes influencing mortality of juvenile pink salmon (*Onchorynchus gorbuscha*) in Prince William Sound, Alaska. M. Willette, et al.

**Chapter 5.** Biological and physical effects on the early life history of herring (*Clupea pallasi*) in Prince William Sound, Alaska. B. Norcross, et al.

**Chapter 6.** Inter-seasonal and annual changes in the distribution and abundance of walleye pollock (*Theragra chalcogramma*) in Prince William Sound. G. Thomas et. al.

**Chapter 7.** Seasonality in surface-layer net zooplankton communities in Prince William Sound, Alaska. T. Cooney, et al.

**Chapter 8.** Vertical and horizontal patterns in the distribution of *Neocalanus* spp. in Prince William Sound, Alaska. J. Kirsch, et al.

**Chapter 9.** Predation on Pacific herring (*Clupea pallasi*) spawn by birds in Prince William Sound, Alaska. M. Bishop, et al.

Chapter 10. Seasonal hydrography and tidal currents in bays and fjords in Prince William Sound, Alaska. S. Gay, et al.

Chapter 11. A simulation of the seasonal ocean circulation patterns/regimes of Prince William Sound, Alaska. J. Wang, et al.

Chapter 12. Effects of fall physiological condition and winter temperature on overwinter survival of age-0 Pacific herring (*Clupea pallasi*). Patrick, et al.

Chapter 13. Effects of juvenile salmon size and foraging behavior on predation risk. M. Willette et al.

#### **PROFESSIONAL CONFERENCES**

Results from the first six chapters of this synthesis were used to project SEA findings at the EVOS 10-year symposium, Anchorage, Alaska, March 23-26. Papers published in the SEA synthesis and/or final report may also be presented and discussed at scientific meetings in 2000, but those costs will be assumed by the presenters.

#### NORMAL AGENCY MANAGEMENT

n/a

## COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Publication tasks will be performed in close coordination with the former SEA Lead Scientist, Dr. T. Cooney and Dr. William Pearcy. Travel is requested for Drs. Cooney, Pearcy, and Allen to meet when necessary to facilitate the publication of the SEA synthesis volume.

#### **EXPLANATION OF CHANGES IN CONTINUING PROJECTS**

n/a

#### PROPOSED PRINCIPAL INVESTIGATOR

Jennifer R. Allen will continue as the PI of project 00320Z2.

#### PRINCIPAL INVESTIGATOR

Dr. Jennifer R. Allen Prince William Sound Science Center P.O. Box 705 Cordova, Alaska 99574 (907) 424-5800 Office (907) 424-5820 Fax jrallen@grizzly.pwssc.gen.ak.us.

Dr. Allen is presently the PI for project 99320Z2 (SEA Synthesis Editor). She has had a central role in developing and maintaining coordination and communication mechanisms within the SEA program, and in communication of SEA findings to the scientific community and the public. She is an experienced author and editor and a graphic presentation specialist.

#### Other Key Personnel

Dr. Ted Cooney, SEA Lead Scientist (Institute of Marine Science, University of Alaska Fairbanks, retired as of 1 July, 1999) - Co-PI

Dr. Bill Pearcy, SEA Synthesis volume guest editor (Oregon State University, retired).

#### **Budget Justification**

#### Introduction

Publication of the major results of SEA will assure both national and international exposure for the Council's restoration work. Much of what is being attempted in Prince William Sound and other locations in the spill-influenced area has application elsewhere. We also predict there will be a demand for the bundled SEA results by those exploring ways tomove toward whole-ecosystem management in the future. Getting SEA's integrated synthesis in front of the broader scientific community will guarantee that Trustee Council restoration results contribute to a growing understanding of how coastal ocean dynamics. This at a time when over fishing, climate change and ocean regime shifts are threatening our living marine resources.

#### Integrated Final Reports of the 5-year SEA program

Alaska Department of Fish and Game has responsibility for copying, binding and distributing the peer-reviewed final report package from SEA. A total of 88 copies will be prepared including 33 for the required ARLIS distribution and 50 copies for SEA program members; PIs, senior scientists technicians and students.

#### The Fisheries Oceanography dedicated volume

The Journal of Fisheries Oceanography provides special volume publication opportunities for large programs relating the production and dynamics of fish production to the marine environment. These dedicated volumes or special supplements are cleared for publication following an extensive external review of manuscripts by a guest editor selected by the Editor-In-Chief (Dr. Michael Mullin, Professor, Scripps Institution of Oceanography, La Jolla, CA.). Dr. Mullin, at the request of Dr. Cooney, appointed Dr. William (Bill) Pearcy to serve as the SEA guest editor.

Research programs seeking single volume publication in Fisheries Oceanography must assume all costs, including a fee for the guest editor, for printing sufficient copies for the current membership, and for printing reprint copies for local distribution. The annual cost of a subscription to this journal in the U.S. is \$310.

Our budget request for publishing a special SEA volume includes 650 copies for the regular FO subscription list, and 250 copies for EVOS distribution (100 for SEA and stakeholders in Prince William Sound, and 150 for the

Trustee Council and its agencies including the required ARLIS distribution.). This number of copies will assure local distribution in the spill effected region, and some for requests that will come in world-wide to the Trustee Council for reprints. We have restricted the use of color and imposed strict page limitations on manuscripts to control the printing costs of the SEA special volume.

Two months of salary are requested for Dr. Allen to coordinate the tasks leading to the successful

prepared 10 April 99

Project 00320-Z2

publication of a SEA special volume of Fisheries Oceanography in 2000. The editors fee for Dr. Pearcy is for professional duties associated with externally reviewing manuscripts.
October 1, 1999 - September 30, 2000

	Authorized	Proposed		PROPOSED	FY 2000 TRUS	TEE AGENCIES	3 TOTALS	
Budget Category:	FY 1999	FY 2000	ADEC	ADF&G	ADNR	USFS	DOI	NOAA
				\$16.6				\$108.5
Personnel	\$0.0							記録時期は
Travel	\$0.0	\$0.0						
Contractual	\$0.0	\$116.9						
Commodities	\$0.0	\$0.0		的这些支持		制作于这次都是	的保護法律行為	
Equipment	\$0.0	\$0.0		LONG	RANGE FUNDI	NG REQUIREMI	ENTS	
Subtotal	\$0.0	\$116.9			Estimated	Estimated		
General Administration	\$0.0	\$8.2			FY 2001	FY 2002		
Project Total	\$0.0	\$125.1			\$0.0	\$0.0		
							经资料 医子宫	
Full-time Equivalents (FTE)	0.0	0.2				之后,取得马克		
			Dollar amount	ts are shown in	thousands of a	Iollars.		
Other Resources	\$0.0	\$0.0			\$0.0	\$0.0		
Comments:								
· · · · · · · · · · · · · · · · · · ·								
							,	
			1					

FY00

Project Number: 00320Z2 Project Title: SEA: Publishing the Integrated Final Reports and a Program Synthesis Lead Agency: NOAA

1

FORM 2A MULTI-TRUSTEE AGENCY SUMMARY

Prepared:

ł

October 1, 1999 - September 30, 2000

Pudget Category	Authorized	Proposed	
Budget Category:	FY 1999	FY 2000	
Personnel		\$0.0	
Travel		\$0.0	
Contractual		\$15.5	
Commodities		\$0.0	
Equipment		\$0.0	LONG RANGE FUNDING REQUIREMENTS
Subtotal	\$0.0	\$15.5	Estimated Estimated
General Administration		\$1.1	FY 2001 FY 2002
Project Total	\$0.0	\$16.6	
Full-time Equivalents (FTE)		0.0	
			Dollar amounts are shown in thousands of dollars.
Other Resources			
FY00	Project Numl Project Title: Synthesis Agency: AD	ber: 00320 SEA: Publi PF&G	Z2 Ishing the Integrated Final Reports and a Program AGENCY SUMMARY

Prepared:

.

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	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
		Subtotal 🖅 😳 👘	0.0	0.0	0.0	
				F	Personnel Total	\$0.0
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
			1		Travel Total	\$0.0
						1010
	Project Number: 0032072					FORM 3B
	Project Titler CEAr Dublishing	the Integrated Final	Donorto ono	Dragram		Parsonnal
FYOO	Froject file: SEA: Fublishing	the integrated Final	i neports and	i a Frogram	'	

Project little: SEA: Publishing the integrated Final Reports and a Program Synthesis

Agency: ADF&G

Prepared:

& Travel

DETAIL

October 1, 1999 - September 30, 2000

Contractual Costs:						Proposed
Description						FY 2000
Final production costs for	the Final Report; No. copi	ies =	88			
	<u>cost/each</u> numbe	er				
Color Copies	98	88				8,624.0
Printing-binding Reports	75	88				6,600.0
Postage	3	88				264.0
Forecasted	final report includes 1000	0 pages with 20	0% color sheets			
· ·						
When a non-trustee organizatio	n is used, the form 4A is	required.			Contractual Tot	al \$15.5
Commodities Costs:			<u></u>			Proposed
Description			· · · · · · · · · · · · · · · · · · ·	• • •		FY 2000
					······	
						· · · ·
		1				
			1			
		<u> </u>	. <u>.</u>			
					Commodities Tota	\$0.0
[]	<u> </u>					
	Project Number:	00320Z2				FORM 3B
EVOO	Proiect Title: SE	A: Publishind	the Integrated F	inal Reports and a P	rogram C	ontractual &
	Synthesis			•		Commodities
	Agonovi ADESC					DETAIL
	Agency: ADrad					

~~

[

October 1, 1999 - September 30, 2000

New Equipment Purchases:	Number	Unit	Pronosed
Description		Price	FY 2000
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by	placement of an R. New Ed	quipment Total	\$0.0
Existing Equipment Usage:		Number	Inventory
Description	······································	of Units	Agency
FY00 FY00	tegrated Final Reports and a Program	F	ORM 3B quipment DETAIL

Prepared:

- ~~

1.

Į

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

	Authorized	Proposed					ASSESSES	
Budget Category:	FY 1999	FY 2000						
Personnel		\$0.0						
Travel		\$0.0						
Contractual		\$101.4						
Commodities		\$0.0		우리에서				
Equipment		\$0.0		LONG	RANGE FUNDIN	IG REQUIREME	NTS	
Subtotal	\$0.0	\$101.4			Estimated	Estimated	]	
General Administration		\$7.1			FY 2001	FY 2002		
Project Total	\$0.0	\$108.5			1	······································		-
			de la compañía de la compañía					
Full-time Equivalents (FTE)		0.2						
	I		Dollar amoun	ts are shown in	thousands of	Iollars	an an an tha an	PERSONAL STREAM PROPERTY PARTIES.
Other Resources	T							
Comments:			<b>I -</b>	I				
Commenta.								
[L						<del></del>		
[}			7.0			]	ا	
	Project Numl	per: 00320	-Z2					FORM 3A
EVOO	Project Title:	SEA: Publi	shing the Int	egrated Fina	I Reports and	l a Program		TRUSTEE
			-		-	-		

Synthesis

Agency: NOAA

Prepared:

AGENCY

SUMMARY



	Authorized	Proposed	
Budget Category:	FY 1999	FY 2000	
Personnel		\$13.8	
Travel		\$6.1	
Contractual		\$64.2	
Commodities		\$0.4	
Equipment		\$0.0	LONG RANGE FUNDING REQUIREMENTS
Subtotal	\$0.0	\$84.5	Estimated Estimated
Indirect		\$16.90	FY 2001 FY 2002
Project Total	\$0.0	\$101.4	
Full-time Equivalents (FTE)		0.2	
			Dollar amounts are shown in thousands of dollars.
Other Resources			
	Project Num	ber: 00320	DZ-2

Project Title: SEA: Publishing the Integrated Final Reports and a Program Synthesis

Name: Prince William Sound Science Center

Prepared:

FY00

Non-Trustee

SUMMARY



October 1, 1999 - September 30, 2000

Pers	onnel Costs:			Months	Monthly	1	Proposed
	Name	Position Description		Budgeted	Costs	Overtime	FY 2000
99 <b>8</b> 9	Jennifer Allen	Synthesis Coordinator & Editor		2.0	6.9		13.8
							0.0
			学校主义的				0.0
							0.0
3.0							0.0
							0.0
			的是我的错				0.0
				۱ I			0.0
			7日子会长生?	1			0.0
							0.0
							0.0
							0.0
		Subtotal		2.0	6.9	0.0	NE CARTAL CONTRACT
l				<u>p</u> :	P	ersonnel Total	\$13.8
Trav	el Costs:		Ticket	Round	Total	Daily	Proposed
1991 March 1994	Description		Price	Trips	Days	Per Diem	FY 2000
	CDV/Corvellie Oregon		750 0			102.0	0.0
	Great Falls/CDV		750.0		4	147.0	2 070 0
$\lambda^{1}$	Great Falls/Corvallis Oregon		750.0	2		147.0	2,370.0
	CDV/Anch		150.0	1	4	160.0	790.0
			150.0	1	+	100.0	0.0
							0.0
							0.0
			1				0.0
			1				0.0
		· · · · · · · · · · · · · · · · · · ·					0.0
							0.0
						Travel Total	\$6.1
		Project Number: 00320-Z2					FORM 4B
		Project Title: SEA: Publishing the In	tegrated Fina	al Renorte and	ta I	F	Personnel
	FYUU	Program Synthesis		a noporto ant		'	& Travel
			0				
Droc	)red:	IName: Prince William Sound Science	Center			Ц	DETAIL

Prepared:



[			
Contractual Costs:			Proposed
Description			FY 2000
Postage			
Telephone			1,000.0
Photocopying			
Network Charge@ 100.	Per computer month		200.0
Software Licenses			
Dr. W. Pearcy, Fisheries	Oceanography guest editor fee		5,000.0
Fisheries Oceanography	publication costs		58,047.0
		Contractual Tot	al \$64.2
Commodities Costs:			Proposed
Description			FY 2000
		Commodities Tota	\$0.4
[]			
	Project Number: 00320-22		
EY00	Project Title: SEA: Publishing the Integrated Final Reports and a		ontractual &
	Program Synthesis		ommodities
	Name: Prince William Sound Science Center		DETAIL
Prepared:	ال		0 - 5 10

÷

#### 2000 EXXON VALDEZ T October 1, 1999 - September 30, 2000

1

New Equipment Pur ies:		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
Those purchases associated	with replacement equipment should be indicated by placement of an R	Now E	guinment Total	\$0.0
Existing Equipment Usage:			Number	1 40.0
Description	·····		of Units	
Prince William Sound S	Science Center network, workstation, personal computer and associated hardware			
FYOO	Project Number: 00320-Z2 Project Title: SEA: Publishing the Integrated Final Reports an Program Synthesis Name: Prince William Sound Science Center	nd a	E	FORM 4B Equipment DETAIL
Prepared:				10 of 10

(



# Project Title: Pigeon Guillemot Restoration Research at the Alaska SeaLife Center

Project Number:	00327
Restoration Category:	Research (continuing)
Proposed By:	Oregon State University (PI - Daniel D. Roby)
Lead Trustee Agency:	DOI
Duration:	3rd year, 4-year project
Cost FY 00:	\$179,000
Cost FY 01:	\$93,000 (estimated)
Geographic Area:	Alaska SeaLife Center, and adjoining areas of Resurrection Bay

Injured Resource/Service: Pigeon Guillemots, other injured seabird resources



# ABSTRACT

This study tests the feasibility of direct restoration techniques for Pigeon Guillemots (e.g., installation of artificial nest sites, use of social attractants, captive propagation and release), a seabird species that was injured by the EVOS and has failed to recover. While raising young guillemots in captivity it will also be possible to conduct controlled experiments crucial to two other restoration objectives: (1) development of nondestructive biomarkers of petroleum hydrocarbon contamination in seabirds, and (2) understanding how dietary factors (prey species composition, prey size, lipid content, feeding frequency) constrain growth, development, and condition at fledging in guillemots and other fish-eating seabirds.





#### **STUDY HISTORY**

The first field season for this study was in 1998. Prior to the 1998 field season, considerable progress was made in setting up the Research Work Order from USGS-BRD to Oregon State University that will fund this project throughout its duration, selecting a graduate student for the project, designing and constructing artificial nest sites, exploration of potential sites for collecting guillemot eggs and young chicks, and obtaining the necessary permits (NEPA, Scientific Collecting) and approvals (IACUC) to conduct the work.

During the 1998 field season a total of 44 guillemot eggs and 2 guillemot chicks were collected from nests in the wild and transported to the SeaLife Center for incubation and/or captive rearing. A total of 23 eggs were hatched (52% hatching success) and a total of 21 chicks were successfully fledged from the roof of the SeaLife Center. Blood samples were collected from chicks at predetermined ages for baseline levels of certain biomarkers. Chicks were raised on one of four types of forage fish: Pacific herring, Pacific sand lance, juvenile walleye pollock, or crescent gunnels. Growth rates were monitored on all chicks.

#### **INTRODUCTION**

The Pigeon Guillemot (*Cepphus columba*) population in Prince William Sound has failed to recover from declines that occurred both before and after the *Exxon Valdez* Oil Spill (EVOS). Post-spill studies of Pigeon Guillemot reproductive success have identified three primary factors preventing recovery:

1) In Prince William Sound (Naked and Jackpot islands) and Kachemak Bay, predation on eggs and chicks has been a major source of nesting failure (Hayes 1996, Prichard 1997, Golet 1999). 2) There has been a decline in the proportion of sand lance in the diet at some guillemot colonies in Prince William Sound (e.g., Naked Island) and Kachemak Bay, and the proportion of highlipid schooling forage fish in the diet has been shown to be a key factor in guillemot reproductive success at both sites. The Alaska Predator Ecosystem Experiment (APEX) Project components F (Factors Limiting Pigeon Guillemot Recovery), G (Seabird Energetics), and M (Seabird/Forage Fish Studies in Lower Cook Inlet) are investigating the relationship between a lack of recovery in guillemot populations injured by the EVOS and the availability and quality of forage fish. A decline in availability of high-lipid forage fishes (sand lance, herring, capelin) in the last two decades may be responsible for lower growth rates, fledging weights, post-fledging survival, and adult recruitment in guillemot populations within the oil spill area.

3) The Nearshore Vertebrate Predator (NVP) Project (River Otter and Pigeon Guillemot component) tested the hypothesis that exposure to residual oil from the spill continues to limit recovery of Pigeon Guillemots. Pigeon Guillemots feed on a diversity of nearshore demersal fishes and schooling forage fish that use the substrate to avoid predators (e.g., sand lance), prey that were likely injured by EVOS. The approach of the NVP study is to measure certain biomarkers in blood and compare biomarker levels in nestlings from oiled and nonoiled areas. These blood biomarkers still need to be calibrated to known doses of weathered Prudhoe Bay Crude Oil (PBCO) in a controlled, laboratory setting.

The proposed research is being conducted at the Alaska SeaLife Center in Seward and addresses all three of the above limiting factors. Experimental studies using captive subjects are integrated with raising Pigeon Guillemot nestlings in captivity in order to establish free-ranging guillemot breeding colonies in the vicinity of the SeaLife Center. Predator-free nest sites have been built in the vicinity of the SeaLife Center and, in association with the use of decoys and audio playbacks of guillemot calls, are being used to help attract and recruit prospecting guillemots to breed. Guillemot populations are frequently nest-site limited (Storer 1952) and Pigeon Guillemots readily breed in anthropogenic structures, such as docks and breakwalls, at many locations throughout the species' range. Like most seabirds, guillemots are philopatric to their natal location, and cohorts raised in captivity at the SeaLife Center and released there can be expected to return and attempt to breed in the surrounding area. Although guillemots only rarely breed



before three years of age, prospecting 2-year-olds that were raised in the first year of this threeyear study can be expected to visit the SeaLife Center during the 2000 breeding season.

Providing artificial nest sites has the potential to restore guillemot populations through enhancing both local recruitment of adults and nesting success. Our success in recruiting prospecting adult guillemots to use artificial nest sites and the proportions of captive-reared and immigrant guillemots that utilize artificial nest sites will allow us to test the feasibility of this direct restoration technique for enhancing recovery of guillemot populations in the EVOS area.

The proposed work is intended to result in the establishment of breeding colonies of free-ranging Pigeon Guillemots near the SeaLife Center. By banding immigrants to the colony and young that are raised and released at the SeaLife Center, we can establish a breeding colony comprised of known-age individuals whose breeding history is known. Accessibility of nest sites can be a major obstacle for studies of factors influencing nesting success and demographics of guillemots, and artificial nests sites can provide investigators with unique opportunities. A dockside Black-legged Kittiwake colony in Great Britain has been studied for the past 30 years and provided most of what is known about that species in the northeastern Atlantic (i.e., Coulson 1988). Establishment of Pigeon Guillemot colonies near the SeaLife Center has the potential of providing a similar resource, in addition to providing opportunities for integration with ASLC's public education program.

Besides providing recruits for the breeding colony of free-ranging guillemots to be established at ASLC, raising chicks in captivity will also provide the opportunity to conduct controlled experiments that are relevant to two major issues in Pigeon Guillemot restoration: (1) the effect of prey type, size, quality, and frequency of delivery on nestling growth rates and condition of young at fledging and (2) the utility of biomarkers in blood and excreta as indicators of exposure to crude oil and other environmental contaminants. Research on these two topics can best be conducted using captive subjects whose environment and diet can be carefully controlled to avoid confounding variables so common in natural populations. In the first year of this study (1998), chicks were raised on different diet regimes to determine the effects of the prey type on growth rates. Chicks were fed either high-lipid schooling forage fishes (sand lance, herring), low lipid forage fish (juvenile walleye pollock), or nearshore demersal fishes (crescent gunnel, high cockscomb) on growth rates. These controlled feeding experiments will be continued in FY 2000. The results from this study will complement continuing studies on the role of diet for productivity of nesting guillemots that are part of the APEX Project.

In FY 2000, the third year of the study, some chicks that are raised in captivity will be fed small, sublethal doses of weathered Prudhoe Bay crude oil (PBCO). Subsequent to dosing, samples of blood and excreta will be collected at prescribed intervals for measurement of biomarkers of health status. These results will allow us to define the dose-response relationship between ingested PBCO and each biomarker of exposure. Such results are essential for evaluating the efficacy of particular biomarkers and the utility of these biomarkers for assessing the exposure of free-ranging guillemots to oil.

Of particular value for interpretation of the results of captive feeding trials and crude oil doseresponse experiments will be the subsequent release of these subjects and measurements of their return rates in subsequent years. Although it can not be assumed that all young guillemots that are fledged from the ASLC and survive to breeding age will return to breed near ASLC, the return rates of nestlings raised on various diets, plus return rates of oil-dosed and control nestlings, will provide valuable information on the long term effects of prey composition and oil exposure for guillemot fitness.

#### NEED FOR THE PROJECT



A. Statement of Problem

Prepared 4/15/99

In the last two decades the Pigeon Guillemot population in Prince William Sound has declined from 15,000 to 5,000 individuals (Laing and Klosiewski 1993). While this decline apparently began prior to the EVOS, an estimated 10-15% of the population in the spill area died as a direct result of the spill. Post-spill censuses have not detected an increase in numbers, suggesting no appreciable recovery has occurred in the aftermath of the spill. Reasons for the lack of recovery are unclear, but may be related to changes in prey resource availability, continuing exposure of guillemots or their prey to oil, or nesting failure due to predation on guillemot eggs and/or nestlings.

Predation on Pigeon Guillemot eggs and chicks was apparently minimal before EVOS, but postspill studies have frequently recorded high levels of predation from river otters and mink (Hayes 1995). High predation rates could be reducing production of local birds, increasing breeding dispersal (lack of fidelity to a previously used nest site or location) of established breeders, and decreasing the immigration of guillemots from other colonies. While Pigeon Guillemots typically have high fidelity to their breeding site, disturbance and lack of breeding success can increase the rate and distance of breeding dispersal. Populations suffering high levels of disturbance, such as persistent nesting failure due to terrestrial predators, will decline due to a lack of production of new recruits, dispersal of breeding birds, and/or decreased immigration.

Two ongoing EVOS projects have identified potential reasons for a lack of recovery by Pigeon Guillemots in the EVOS area. The APEX Project has identified a major shift in the nearshore ecosystem that has apparently resulted in fewer high-lipid schooling fish, particularly sand lance (*Ammodytes hexapterus*) fed to chicks (Oakley and Kuletz 1994, Golet et al. unpubl. ms.). Prespill studies found sand lance, a nearshore schooling fish with relatively high average energy density, to be the dominant prey returned to chicks. Post-spill studies have found gadids and nearshore demersal fish to constitute the majority of the diet. The NVP project has attempted to determine if blood biomarkers can be used to monitor level of exposure to oil and if blood from individuals in wild populations currently indicates exposure to oil is occurring. Both of these projects have examined wild populations that are exposed to numerous sources of variability that confound the examination of factors affecting chick growth or blood biomarkers.

This study is relevant to EVOS Restoration Work because it is designed to develop direct restoration techniques for Pigeon Guillemots, a species injured by the spill that is failing to recover. Techniques developed during this study will be relevant to restoration of other alcid species. Also, dose-response experiments with guillemot nestlings fed small, sublethal amounts of weathered Prudhoe Bay crude oil will provide crucial validation and calibration results for interpretation of on-going studies of biomarkers as indicators of crude oil exposure. Experimental studies with captive-reared guillemots will also provide a better understanding of how shifts in the diet of guillemots and other seabirds breeding in the EVOS area affects growth, development, fledging condition, and, ultimately, fitness. By monitoring the growth and development of nestlings raised on controlled rations, the relative nutritional quality of various prey can be assessed. Also, fitness tradeoffs between prey size/quality and provisioning rate can be assessed through monitoring of subsequent survival in the wild of captive-reared chicks. Understanding the constraints imposed on guillemots by diet composition, oil exposure, and nest site quality will be crucial for designing management initiatives to enhance productivity in this and other seabird species that are failing to recover from EVOS.

#### B. Rationale/Link to Restoration

Artificial nest sites have the potential to increase the size of both guillemot breeding colonies and populations. A Black Guillemot colony in arctic Alaska increased from 10 to 225 pairs in 17 years through provision of artificial nest sites (Divoky et al. 1974 and in prep.). In Washington State 27% of the 33 Pigeon Guillemot colonies are in piers or other anthropogenic structures (Speich and Wahl 1989). Establishment of a Pigeon Guillemot colony near the Alaska SeaLife Center will demonstrate the utility of direct restoration in assisting the recovery of Pigeon Guillemot populations in the northern Gulf of Alaska. If artificial nest sites are successful in

attracting breeding adults and if successful reproduction ensues, artificial nest sites can be used in Prince William Sound to enhance productivity, recruitment, and immigration, all of which will facilitate recovery. Clusters of artificial nest sites similar to those at the ASLC can be installed near natural colonies that suffer from chronically high nest predation rates. Nests could be placed on pilings or "dolphins" constructed specifically for colony development.

Aside from providing prototypes for artificial colonies in other parts of the EVOS area, a breeding colony of free-ranging guillemots at the ASLC will allow investigators to conduct research on Pigeon Guillemots that would not be possible at natural colonies. Loss of eggs or chicks to predation has been a major source of nest failure in post-spill studies of Pigeon Guillemots in Prince William Sound (Hayes 1995, Golet 1999). In addition, marked adults and returning young will allow an examination of demographics that has not been possible in Prince William Sound studies. A lack of recovery could be due to demographic parameters (e.g., adult survival, subadult survival, immigration/emigration rates) not evident in studies of nesting success or colony censuses. Guillemot demographics are much more easily studied at a colony of artificial nest sites where the banding of chicks and adults entails far fewer problems than at natural colonies. Should the proposed work result in the deployment and use of significant numbers of artificial nest sites in Prince William Sound, investigators will be able to obtain demographic information for that area that could explain the lack of recovery of local populations.



While the colonies of Pigeon Guillemots that we are attempting to established near the ASLC will have the benefit of captive-reared chicks returning to their natal location and assisting in establishment of the colony, immigration is obviously the source of adults founding new colonies. Immigrants can also be the primary source of recruits to established and expanding colonies (Petersen 1981). Unlike many seabirds, guillemots are semi-colonial and able to breed as single pairs as well as colonially. Prospecting guillemots can be expected to search for nesting opportunities more extensively than more colonial seabirds, which require minimum numbers of conspecifics for successful breeding. Nest sites at ASLC are likely to attract nonbreeding prospectors from the approximately 100 pairs of Pigeon Guillemots breeding between Aialik Cape and Cape Resurrection (Nishimoto and Rice 1987), as well as more distant colonies. An expanding colony of Black Guillemots in arctic Alaska drew most of its recruits from colonies more than 400 km distant (Divoky, in prep.).

A Pigeon Guillemot colony could also have the potential of attracting other seabird species to nest in the area of ASLC. Some of these other species may also be recruited by providing nest sites. A Black Guillemot breeding colony that utilized artificial nest sites in arctic Alaska also attracted Horned Puffins (*Fratercula corniculata*), some of which used the artificial nest sites (Divoky 1982 and unpubl.).

The research component of this study will allow evaluation and validation of the use of nondestructive biomarkers (in blood and excreta) to assess the health status of individual guillemots and potential exposure to petroleum hydrocarbons. There is evidence that certain acute phase proteins (i.e., haptoglobin) in blood and porphyrins in excreta are induced by ingestion of sublethal doses of weathered crude oil (Prichard et al. 1997). The results of a dose-response experiment with wild guillemot nestlings in their natural nest sites, however, were ambiguous because of among-site variability in baseline values for biomarkers (Prichard et al. 1997). Also, guillemot nestlings were fed small doses (0.05-0.2 ml) of highly weathered PBCO in that study; and the dose levels were not sufficient to cause even a significant decline in growth rates of nestlings. Finally, blood samples for measuring biomarker levels were not collected until five days post-dosing, when any induction of an acute phase response had already likely peaked. Regardless of all these uncontrolled factors, the serum haptoglobin levels in guillemot chicks fed 0.2 ml of weathered PBCO were significantly different from that of controls. While the use of blood and fecal biomarkers for monitoring oil exposure and general population health of guillemots is promising, more research under controlled, captive conditions is required to

validate the techniques and provide a sound basis for interpretation of results from wild guillemots.

There is a definite need for information on the relationship between diet and reproductive success for Pigeon Guillemots, a seabird species that is failing to recover from EVOS at an acceptable rate. Guillemots are the most neritic members of the marine bird family Alcidae (i.e., murres, puffins, and auks), and like the other members of the family, capture prey during pursuit-dives. Pigeon Guillemots prey on a wide variety of fishes, including schooling forage fish (e.g., sand lance, herring, pollock) and subtidal/nearshore demersal fish (e.g., gunnels, blennies, sculpins; Drent 1965, Kuletz 1983). There is strong evidence of a major shift in diet composition of guillemot pairs breeding at Naked Island. Sand lance were the predominant prey fed to young in the late 1970s (Kuletz 1983), but currently sand lance is a minor component of the diet (G. Golet, unpubl. ms.). In contrast, guillemots breeding in Kachemak Bay continued to provision their young predominately with sand lance up through the 1996 breeding season, and sand lance was particularly prevalent in the diet at sites that support high densities of breeding pairs (Prichard 1997). Also, young of breeding pairs that provisioned their nestlings with mostly sand lance had higher growth rates (Prichard 1997, Golet et al. unpubl. ms.). Jackpot Island in southwestern Prince William Sound supports the highest nesting densities of guillemots anywhere in the Sound and growth rates of nestlings are correspondingly high. The high availability of juvenile herring to guillemots nesting at Jackpot Island may be responsible for both the high nesting density and high growth rates. Thus availability of high-quality schooling forage fishes (herring, sand lance) may be crucial for maintaining high nesting densities of guillemots.

## C. Location

Pigeon Guillemot nestlings will be raised in captivity at the Alaska SeaLife Center in Seward during FY 00. Guillemot nestlings will be hatched from eggs obtained from source colonies on the Kenai Peninsula, Kodiak Island, un-oiled parts of Prince William Sound, or at other appropriate northern Gulf of Alaska colonies. Eggs that fail to hatch will be replaced with young nestlings (< 7 days post-hatch) collected from other colonies. Impact of these collections on the productivity of source colonies will be minimal, as eggs lost during the first half of incubation are usually replaced during renesting and the majority of guillemot nesting attempts in the NGOA fail to produce fledglings because of high nest predation rates. Most of the captive-reared fledglings will be banded and released at ASLC to assist in efforts to establish local breeding colonies of free-ranging guillemots near ASLC. Artificial nest sites will be maintained near ASLC on an adjacent breakwall and other sites to enhance the prospects for colony establishment. Colonies in Resurrection Bay that may serve as sources of immigrants or may recruit captive-reared guillemots will be censused and checked for banded adults during the third year of the project. The information obtained from this project will benefit Pigeon Guillemot populations in the Gulf of Alaska, especially Prince William Sound. An understanding of the affect of prey type on chick growth will help explain the role of ecosystem shifts in continuing declines of Pigeon Guillemot populations. Assessing the utility of blood biomarkers for detecting and quantifying exposure to crude oil will benefit efforts to monitor the health status of Pigeon Guillemot populations throughout the spill zone without resort to lethal sampling procedures.

#### COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

All research will be conducted at the Alaska SeaLife Center, which will allow the community in and around Seward to observe progress in the establishment of guillemot colonies in both artificial and natural nest sites. Wild breeding colonies near ASLC have the potential for involving science classes from local schools. The location of colonies will potentially permit easy viewing by the public and allow science teachers to use the colony for instruction about seabird breeding biology and restoration. Science classes could conduct observations on the occurrence and activities of prospecting and breeding guillemots. Some of these (timing of arrival in the spring and sightings of color banded adults) could provide important information for the period when the investigators are not in Seward. Local science teachers can receive annual summaries of information about local colonies (e.g., timing of clutch initiation, breeding success) that can provide the basis for lessons on regional climate change and annual variability in the marine environment. The Seaquest Program of the Chugach School System would be a logical avenue for presenting this material to students.

#### **PROJECT DESIGN**

#### A. Objectives

This research project has three primary objectives listed below. During the third year of the project (FY 00), the emphasis will be on achieving all three objectives.

- 1. Determine the feasibility of using direct techniques for restoration of Pigeon Guillemots, including:
  - a) providing artificial nest sites
  - b) use of social attraction, such as decoys and playbacks of vocalizations
  - c) release of captive-reared young
- 2. Determine the response of particular biomarkers of crude oil exposure (acute phase proteins, plasma sodium, fecal porphyrins) to variables of exposure in guillemot nestlings, and the survival of exposed nestlings post-fledging. Exposure variables that will be examined include:
  - a) dose of ingested oil
  - b) degree of weathering of ingested oil
  - c) time since ingestion of dose
  - d) number of previous exposures
- 3. Determine the effect of diet variables on growth performance, development, fledging condition, and post-fledging survival of Pigeon Guillemots, including:
  - a) type of forage fish consumed, with emphasis on high-lipid forage fishes vs. low-lipid fishes
  - b) lipid content of the diet
  - c) size of prey items
  - d) frequency of prey delivery

#### **B.** Methods

The proposed work will test the following three basic hypotheses, which relate to each of the three primary objectives listed above:

**Hypothesis 1**. Artificial nest sites, decoys, and playbacks of vocalizations can be used to establish new Pigeon Guillemot breeding colonies and enhance breeding success over that experienced at natural colonies using natural nest sites.

**Hypothesis 2**. Biomarkers from plasma and excreta of nestling Pigeon Guillemots can be used as indicators of exposure to weathered crude oil in the food supply, and the subsequent survival probabilities of young guillemots post-fledging.

**Hypothesis 3**. Growth performance, fledgling condition, and post-fledging survival of Pigeon Guillemot nestlings are sensitive to differences in prey type, prey size, feeding frequency, and lipid content of prey.

Methodology employed during the third year of the study (FY 00) will consist of the following:

#### **Objective 1: Testing Feasibility of Direct Restoration Techniques**

Prepared 4/15/99



#### a. Installation of Artificial Nest Sites and Use of Social Attraction

Pigeon Guillemot nest sites have been constructed and installed at several locations in the vicinity of the Alaska SeaLife Center. Additional nest sites will be provided at each location if the number of breeding birds and prospecting adults exceeds the number of available nest sites. Design of the artificial nest sites was based on the sites developed by Dr. Divoky for Pigeon Guillemots in Puget Sound, with modifications based on studies of nest site characteristics that were associated with nesting success in Kachemak Bay (Prichard 1997). Sites have two entrances with a central nesting cavity. Baffles in the entryways to the nest cavity prevent avian predators from viewing nest contents. Based on the locations of Pigeon Guillemot nest sites associated with docks and piers, it appears that placing the sites beneath an overhang will increase their attractiveness to guillemots prospecting for nest sites. Sites under an overhang apparently have the advantage of decreased avian predation. Sites are large enough to accommodate monitoring devices (such as a closed circuit camera, platform scale, or activity monitor) that may be used in future research.

Guillemot decoys have been made from molds produced by Mad River Decoy in Vermont. A CD player with external speakers was used to play adult Pigeon Guillemot calls from May to mid August. Because prospectors may make recruitment decisions based on local breeding productivity (Boulinier et al. 1996), from late June to late August the calls of chicks in nest sites were also be played during the early morning and evening, when colony attendance can be expected to be highest. Similar combinations of decoys and audio playbacks have been used successfully for other seabird species, including alcids (Kress and Nettleship 1989, Kress 1983), but have never before been used to attract guillemots to nest at new locations.

We will begin systematic observations of artificial nest sites and decoy sets in May. Daily observations will be conducted at the times expected to have maximum colony attendance (0200-0900 and 1600-2000 Alaska Daylight Time, high tides). Initially observations will be recorded every 15 minutes on the number of Pigeon Guillemots visible from the roof of ASLC and their distance from artificial nest sites. Once guillemots begin associating with decoys and nest sites, we will conduct detailed observations on the behavior of prospecting birds. The location and activities of prospectors will be recorded during 15-minute periods. Behavioral observations will be similar to those conducted by Preston (1968) on Black Guillemot social behavior.

#### b. Monitoring of Pigeon Guillemot Breeding Biology and Demographics

Should breeding occur in the artificial nest sites in 2000, we will obtain information on the breeding biology of birds using the nest sites. To reduce the chances of nest site abandonment, no adults will be captured during 1999, but if successful breeding takes place in 1999, we will attempt to noose breeding adults for banding in 2000. In 2000 the following breeding parameters will be monitored:

- date of clutch initiation
- egg weight and volume
- egg color and pattern
- date of hatching
- weight at hatching
- hatching success
- growth rate (measured every two-four days)
- fledging weight
- fledging age
- fledging success

The observations on breeding chronology and success can be compared with ongoing monitoring of Pigeon Guillemot nesting in Prince William Sound and Kachemak Bay. Additionally the

Prepared 4/15/99



information on egg size and color can be used in future years to assess the potential of using egg characteristics to measure female survival and recruitment.

During the nestling period we will conduct observations on the prey types delivered to chicks. These observations will determine the taxonomic composition of nestling diets at each nest and collectively. These observations will be compared with diet data collected at natural colonies in Prince William Sound and Kachemak Bay (Golet unpubl. ms., Prichard 1997).

#### c. Captive-rearing of Chicks

Guillemot eggs will be collected throughout June and into early July, during the mid- to late incubation period. Eggs will be collected from nests on the Kenai Peninsula, Kodiak Island, unoiled portions of Prince William Sound, or other locations in the northern Gulf of Alaska. Collection will occur late in incubation, when feasible, in order to maximize hatching success. In 1998 we learned that eggs collected later in the incubation period had the highest chances of hatching. Eggs will be transported to the ASLC in electric brooder boxes and incubated in a large cabinet incubator operated by ASLC until they hatch or it becomes clear the eggs are infertile or addled. If the sample size of chicks hatched from eggs in captivity is low, we will collect guillemot chicks from nests shortly after hatching in order to meet target sample sizes for numbers of chicks raised in captivity and released at ASLC. Chicks translocated later in the nestling period display philopatry to the location of hatching, instead of fledging (Serventy 1967, Fisher 1971).

The source colonies for eggs or hatchling guillemots will be primarily on the Kenai Peninsula, Kodiak Island, and un-oiled portions of Prince William Sound. Collection sites will be selected based on the numbers of breeding pairs at each colony and the accessibility of individual nests. The proposed area where collections will occur has more than an adequate breeding population of Pigeon Guillemots to support the collections we propose without a detectable impact on existing colonies. We will collect a minimum of 60 guillemot eggs or very young chicks during the 2000 breeding season with the goal of successfully raising and releasing at least 40 captive-reared fledglings into the wild at ASLC. When two-egg clutches are encountered in the field, we will collect both eggs in the clutch in order to enhance the incidence of clutch replacement at source colonies. Assuming a level of philopatry similar to that observed for Black Guillemots (Divoky, in prep.), 35% of fledging guillemot chicks should ultimately return to ASLC from the 2000 cohort, providing >14 potential recruits to local breeding colonies. If all surviving captive-reared guillemots recruit at the natal location, a colony of > 20 breeding pairs should be present by 2004, even if the sites do not attract immigrants from other natural colonies before that time.

#### d. Release of Captive-reared Chicks

Guillemots fledge at night as early as 30 days after hatching, with most fledging after 35 days (Hayes 1995). Fledglings are able to fly at the time of nest departure, are close to adult size, and are independent of parental care after they fledging. When captive-reared chicks reach 32 days of age, they will be moved in their containers to the roof of ASLC. The covers will be removed from the buckets after sunset and chicks provided the opportunity to fledge. To insure that no predation by gulls or other avian predators occurs, project personnel will attend the chicks whenever they are on the roof. Fledglings will be taken to the roof nightly until all have fledged. Fledglings will be banded with a stainless steel U.S. Fish and Wildlife band and a unique combination of color polyvinyl chloride bands to allow individual identification at a distance. The latter will be sealed with an adhesive to reduce band loss.

#### e. Assessment of Size and Productivity of Pigeon Guillemot Colonies in Resurrection Bay

A census of guillemot colonies in Resurrection Bay and adjacent areas will facilitate understanding of the conditions contributing to the establishment of artificial colonies near ASLC. Immigration constituted the majority of recruits at a colony of Black Guillemots in arctic Alaska that was enhanced using artificial nest sites, and Pigeon Guillemots fledging from local natural colonies in Resurrection Bay that have yet to breed can be expected to prospect the sites near ASLC. To assess the size of these potential source populations and their annual productivity we will attempt to census as many local colonies as possible in 2000 and, when possible, determine breeding productivity. If Pigeon Guillemot nests at these colonies are accessible, we will band nestlings. Resightings of these guillemots at ASLC will provide information on dispersal distance for this species. Intercolony visits are common for pre-breeding alcids (Harris 1983, Kress and Nettleship 1989), and in 2000 we will search these colonies for banded individuals that were raised in captivity at ASLC in 1998 and 1999.

# Objective 2. Validation and Calibration of Nondestructive Biomarkers for Monitoring the Health and Exposure to Oil of Guillemots

#### a. Measurement of Certain Blood Biomarkers of Petroleum Hydrocarbon Exposure

In the third year of this study (FY 00), research on blood biomarkers of oil exposure will include controlled dose-response experiments with weathered Prudhoe Bay Crude Oil (PBCO). A range finding experiment will be conducted to determine the no-effect dose for guillemot chicks consuming weathered PBCO. We will also determine the time course of biomarker response to ingestion of PBCO, including the time post-ingestion when biomarker induction is no longer detectable. At 20, 25, and 30 days post-hatch, we will feed guillemot chicks small, sublethal doses of weathered PBCO in number 2 gelcaps that are inserted into the abdominal cavity of a fish that is then fed to the nestling. Eight guillemot nestlings raised on herring (see below) will be assigned to each of the following oil ingestion treatments: control, 0.5 ml of weathered PBCO, and 1.0 ml of weathered PBCO. Control chicks will receive 1 ml of corn oil in a number 2 gelcap inserted in a food fish. We know from previous experiments (Prichard et al. 1997) that a dose of 0.2 ml of weathered PBCO ingested three times during the latter part of the nestling development period does not have a significant effect on growth of Pigeon Guillemots. Consequently, these doses are designed to identify the "no-effect" dose for weathered PBCO.

Just before and following ingestion of the oil dose, we will collect 1 ml of blood in heparinized vials by puncturing the jugular vein. Blood samples will be collected at 0 h, 12 h, 24 h, and 48 h post-injestion of oil. Previous experiments (Prichard 1997) indicate that there is no significant difference in most blood biomarker levels five days after oil dosing, so this time course of blood samples is designed to reveal the time course of biomarker induction from crude oil injestion. Blood samples will be kept cool and centrifuged at 3,000 rpm for 20 minutes. Plasma will then be removed with a pipette and stored in snap-top plastic vials at -20°C for laboratory analysis at the University of California Davis. In the lab, we will measure haptoglobin and other acute phase protein levels in plasma samples in order to determine dose-response and time course of the response. Assays for blood biomarkers will be conducted in the laboratory of Dr. Scott Neuman at UC Davis. Blood biomarker levels will be compared among the control chicks raised on the three diets (see below) to assess the role of diet in determining baseline biomarker levels, relative to induction caused by ingestion of PBCO.

#### b. Measurement of Biomarkers in Excreta

In addition to collection of blood samples, samples of excreta will be collected over 24-h intervals each day after the initial dosing of PBCOin order to measure fecal porphyrin levels and determine dose-response and time course of response. As with blood biomarkers, responses in fecal porphyrin levels will be compared among the three diet groups. Measurements of fecal porphyrins in excreta will be conducted in the laboratory of Dr. Larry Duffy at the University of Alaska Fairbanks.

Objective 3. Captive Feeding Trials to Assess the Relationship between Diet and Postnatal Development in Guillemots

a. <u>Comparison of Guillemot Growth Performance on Diets of High-lipid or Low-lipid Schooling</u> Forage Fish

In FY 00, 8-12 guillemot chicks will be raised on each of three diets: (1) 150 g of herring per day, (2) 150 g of sand lance per day, or (3) 150 g of juvenile walleye pollock per day. All of these prey species are major components of guillemot chick diets at certain sites and the three species are representative of the two very different lipid levels in guillemot prey. These daily rations are designed so as to provide a variety of caloric and lipid consumption rates that are within the normal range experienced by guillemot nestlings, but biomass consumption rates would be the same for each diet group. Herring and sand lance are representative of high-lipid forage fishes with relatively high energy densities. Juvenile walleye pollock are representative of low-lipid forage fishes with relatively low energy densities. Each chick will be kept in a separate cage so that food consumption can be monitored individually. The daily rations will be provided to most chicks in four daily feedings of 38 g each at about 10:00, 13:00, 16:00, and 19:00 ADT. Each day prior to the first feeding the body mass, wing length, and outer primary length of each chick will be measured until each captive-reared chick fledges into the wild, at about 35-40 days post-hatch. Return rates of subadults in the fourth year of this study will allow us to assess the role of prefledging nutrition and fledging mass on subsequent post-fledging survival.

#### CY 2001

In 2001 none of the direct restoration activities listed above for 2000 will be conducted, but after 2000 we will attempt to locate guillemots that were raised at the Alaska SeaLife Center at regional colonies during our surveys.

Approval of the field protocols for work with live birds described in this DPD have been obtained from the Institutional Animal Care and Use Committee at Oregon State University and from ASLC. Any take of eggs or incidental/unintentional take of nestling or adult guillemots will be covered by relevant Federal and State Scientific Collecting permits. All fledgling, captivereared guillemots released to the wild will be banded with USFWS stainless steel leg bands and polyvinyl colored leg bands under a Master Station banding permit held by the Oregon Cooperative Fish and Wildlife Research Unit.

#### C. Contracts and Other Agency Assistance

Laboratory analyses of the biochemical composition and energy content of forage fishes fed to captive guillemots and the proximate composition of chick carcasses will be conducted in the laboratory of the PI at Oregon State University.

Analyses of biomarkers in blood plasma and fecal samples will be conducted in the labs of Dr. Scott Neuman at the University of California Davis and of Dr. Lawrence K. Duffy at the University of Alaska Fairbanks, where the expertise is available to perform these tasks.

#### **SCHEDULE**

#### A. Measurable Project Tasks for FY 00 (February 1, 2000 - January 31, 2001

May 1 - May 15: Install artificial nest sites, decoys, and playback sound equipment at SeaLife Center.

May 15 - September 10: Collect field data on guillemot use of artificial nest sites, raise guillemot nestlings in captivity, conduct captive rearing experiments, and release captive-reared fledglings.

#### Sept. 10 - Dec. 31: Enter, analyze, and interpret field data and data collected from captivereared chicks. Conduct laboratory analyses of plasma samples, diet



samples, and chick carcass samples.

January 1 - 14:	Prepare for Annual Restoration Workshop
January 15 - 24:	Attend Annual Restoration Workshop and present FY 00 results to peer reviewers.
Jan. 24 - April 14:	Prepare 2000 annual report of findings.
April 15:	Submit annual report (FY 00 findings) Submit FY 01 DPD to Trustee Council

#### **B.** Project Milestones and Endpoints

TX7 00

<u>F I 00</u>	
May 15, 2000	Installation of artificial nest sites, decoys, and audio equipment near the Alaska SeaLife Center
September 10, 2000	Completion of third and final field season, release of third cohort of captive-reared nestlings, collection of blood and fecal biomarker samples for dose-response experiment, completion of captive-feeding trials comparing nestling growth performance on high lipid and low-lipid schooling forage fishes.
April 15, 2000	Completion of third annual report of findings
<u>FY 01</u> June 30, 2001:	Completion of M.S. thesis
September 30, 2001	Completion of Objectives 2 and 3 and submission of manuscripts addressing these objectives

#### C. Completion Date

The anticipated completion of this project will be early in FY 02, at the end of calendar year 2001. This will allow adequate time to complete data analysis, thesis preparation by the Masters student, and manuscript preparation and submission following the last field season in 2000 and completion of laboratory analysis early in 2001.

# PUBLICATIONS AND PROJECT REPORTS

The following publications are projected for this research project (this is a <u>rough</u> projection and by no means complete):

An annual report for the third year of this project will be submitted by 15 April 2001. The final report for this project will be submitted 15 December 2001. At least three manuscripts will be generated from this research, and all will be published in the peer-reviewed scientific literature. Each of these three manuscripts will address one of the three major objectives/hypotheses of this study: (1) guillemot colony establishment as a direct restoration technique, (2) biomarkers as a means of assessing exposure of guillemots to crude oil, and (3) diet as a factor in nestling growth and post-fledging survival. A portion of the final report will be excerpted from the thesis of the M.S. student on this project. This student will be strongly encouraged and directly assisted by the

PI to submit for publication in the peer-reviewed scientific literature the results from this research.

## COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The research described in this proposal takes advantage of the new research facilities and potential represented by the Alaska SeaLife Center and dove-tails nicely with continuing research as part of the APEX and NVP projects that assesses factors limiting recovery of Pigeon Guillemot populations damaged by EVOS. It is also relevant to efforts toward developing seabird models as upper trophic level sentinels of oil pollution in nearshore ecosystems. The proposed research approach utilizes growth performance, fledgling body condition, and blood and fecal biomarkers to assess the health status of guillemot nestling exposed to oil and raised on different diet rations. These data are essential for developing techniques for long term monitoring of the health and status of guillemot populations in the EVOS area.

Studies of foraging, reproduction, and population recovery following the EVOS are on-going for pigeon guillemots. This proposal complements and enhances other studies on pigeon guillemots, without duplication of effort. The PI on the present proposal has been and will continue to work closely with David Irons and Greg Golet (PIs on APEX Component 00163 F "Factors Affecting Recovery of PWS Pigeon Guillemot Populations"), Dave McGuire (Co-PI on NVP studies of biomarkers of oil exposure in guillemot nestlings), and John Piatt (PI on APEX Components 00163 M "Lower Cook Inlet Forage Fish Studies" and 99163 N "Black-legged Kittiwake Feeding Experiment") in developing protocols for collecting data.

#### PRINCIPAL INVESTIGATOR

Daniel D. Roby Oregon Cooperative Fish and Wildlife Research Unit Department of Fisheries and Wildlife 104 Nash Hall Oregon State University Corvallis, Oregon 97331-3803 tel: 541-737-1955 fax: 541-737-3590 e-mail: robyd@ucs.orst.edu

The PI has extensive experience with studies of the reproductive biology of high latitude seabirds and the relationship between diet composition and productivity. He is currently the PI of the Seabird Energetics component (Component G) of the APEX Project and Co-PI of the Diet Quality and Chick Growth component (Component N) of the APEX Project. He has been involved in research on the factors constraining recovery of Pigeon Guillemots in the EVOS area for the last four years.

#### **OTHER KEY PERSONNEL**

The proposed research will be implemented by the Oregon Cooperative Fish and Wildlife Research Unit, closely coordinated with and in cooperation with personnel of the Alaska SeaLife Center in Seward. The PI will receive major assistance in conducting the direct restoration aspects of this research project from Dr. George Divoky, Postdoctoral Research Associate, who has over 20 years of research experience with guillemots and has been instrumental in designing techniques for direct restoration of guillemot populations. In addition, the PI will be assisted in experiments with captive-reared chicks by Dr. Andrew Hovey, a graduate student in the Department of Fisheries and Wildlife at Oregon State University, and an undergraduate research assistant. Laboratory analyses of the proximate composition of diet samples and chick carcasses will be conducted in the laboratory of the PI at Oregon State University. Assays of plasma and fecal biomarkers will be conducted in the laboratories of Drs. Scott Neuman (UC Davis) and Lawrence Duffy (University of Alaska Fairbanks). To the PI's knowledge, the expertise and equipment necessary for the proposed research are not available within the federal and state agencies that comprise the Trustees Council.

#### LITERATURE CITED

- Asbirk, S. 1979. The adaptive significance of the reproductive pattern in the Black Guillemot *Cepphus grylle*. Videnskabelige Meddelelser Dansk Naturhistorisk Forening 141:29-80.
- Boulinier, T., E. Danchin, J.-Y. Monnant, C. Doutrelant, and B. Cadiou. 1996. Timing of prospecting and the value of information in a colonial breeding bird. Journal of Avian Biology 27:252-256.
- Coulson, J. C. 1988. Lifetime reproductive success in the Black-legged Kittiwake (*Rissa tridactyla*). Pages 2141-2147 in H. Ouellet, (Ed.). Acta Congressus Internationalis Ornithologici. Volume II. National Museum of Natural Sciences, Ottawa.

Coulson, J. C., and C. S. Thomas. 1985. Changes in the biology of the Kittiwake *Rissa* tridactyla: a 31-year study of a breeding colony. Journal of Animal Ecology 54:9-26.

Divoky, G. J. 1982. The occurrence and behavior of non-breeding Horned Puffins at Black Guillemot colonies in northern Alaska. Wilson Bulletin 94: 356-350.

Divoky, G. J., G. E. Watson, and J. C. Bartonek. 1974. Breeding of the Black Guillemot in northern Alaska. Condor 76:339-343.

- Drent, R. H. 1965. Breeding biology of the Pigeon Guillemot Cepphus columba. Ardea 53:99-160.
- Fisher, H. I. 1971. Experiments on homing in Laysan albatrosses (*Diomedea immutabilis*). Condor 73:389-400.
- Harris, M. P. 1983. Biology and survival of the immature Puffin, *Fratercula arctica*. Ibis 125:56-73.
- Hayes, D.L. 1995. Recovery monitoring of pigeon guillemot populations in PWS, Alaska. Exxon Valdez Oil Spill Restoration Project Final Report, Project 94173. USDI Fish and Wildlife Service, Anchorage, AK.
- Hayes, D.L. 1996. A comparison of the breeding biology and feeding ecology of pigeon guillemots at Naked and Jackpot Islands in PWS, Alaska. Appendix F in D.C. Duffy, compiler. APEX: Alaska Predator Ecosystem Experiment. Exxon Valdez Oil Spill Restoration Project Annual Report, Project 95163. USDI Fish and Wildlife Service, Anchorage, AK.

Kress, S. 1983. The use of decoys, sound recordings, and gull control for re-establishing a tern colony in Maine. Colonial Waterbirds 6:185-196.

Kress, S. W., and D. N. Nettleship. 1988. Re-establishment of Atlantic Puffins (*Fratercula arctica*) at a former breeding site in the Gulf of Maine. Journal of Field Ornithology 59:161-170.

Kuletz, K. J. 1983. Mechanisms and consequences of foraging behavior in a population of breeding Pigeon Guillemots. M.S. Thesis. University of California, Irvine.

Laing, K. K., and S. P. Klosiewski. 1993. Marine bird populations of Prince William Sound, Alaska, before and after the Exxon Valdez oil spill. Bird Study No. 2. Final Report. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska.

Nishimoto, M. and B. Rice. 1987. A re-survey of seabirds and marine mammals along the south coast of the Kenai Peninsula, Alaska during the summer of 1986. Unpubl. Rept. USFWS, Homer, Alaska and Natl. Park Serv., Anchorage, Alaska.

Oakley, K., and K. J. Kuletz. 1996. Population, reproduction and foraging ecology of pigeon guillemots at Naked Island, Prince William Sound, Alaska, before and after the Exxon Valdez oil spill. Pages 759-769 in S.D. Rice, R.B. Spies, D.A. Wolfe, and B. Wright, eds. Proceedings of the Exxon Valdez oil spill symposium. Am. Fisheries Soc. Symposium. 18.

Petersen, A. 1981. Breeding biology and feeding ecology of Black Guillemots. Ph.D. Thesis. Oxford University, Oxford.

Preston, W. C. 1968. Breeding ecology and social behavior of the Black Guillemot Cepphus grylle. Ph.D. Thesis. University of Michigan, Ann Arbor.

Prichard, A. K. 1997. Evaluation of Pigeon Guillemots as bioindicators of nearshore ecosystem health. Unpubl. M.S. thesis, University of Alaska Fairbanks. Serventy, D. L. 1967. Aspects of the population ecology of the Short-tailed Shearwater

(Puffinus tenuirostris). Proc. Intl. Ornithol. Congr. 14:165-190.

Speich, S. M., and T. R. Wahl. 1989. Catalog of Washington seabird colonies. U.S. Fish and Wildlife.

Storer, R. W. 1952. A comparison of variation, behavior and evolution in the seabird genera Uriaand Cepphus. University of California Publications in Zoology 52:121-222.

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

.

<u> </u>	Authorized	Proposed		
Budget Category:	FY 1999	FY 2000		
Personnel		\$0.0		
Travel		\$0.0		
Contractual	\$150.1	<b>\$167.3</b>		
Commodities		\$0.0		
Equipment		\$0.0	LONG RANGE FUNDING REQUIREMENTS	
Subtotal	\$150.1	\$167.3	Estimated Estimated	
General Administration		\$11.7	FY 2001 FY 2002	
Project Total	\$160.6	\$179.0	\$93.6	
Full-time Equivalents (FTE)	1.3	1.3		(1) 建设 (2) 操作
	······································		Dollar amounts are shown in thousands of dollars.	
Other Resources				
Comments:				
FY00 costs are higher than were	e estimated (\$1	168.8). The di	fference is mostly in higher transportation costs within Alaska to collect	guillemot
eggs and chicks for rearing bac	k at the SeaLife	e Center.		
·				
	r			
	Project Nun	nhor 0022		FORM 3A
			'	DIIQTEE
FY00	Project litle	e: Pigeon G	uillemot Restoration Research at the Alaska	NUSIEE
	Sealife Cen	iter		AGENCY
	Agency: D	OI: U.S. Ge	eological Survey S	UMMARY
Prepared:				1

.

,

October 1, 1999 - September 30, 2000

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
Name	Position Description		Step	Budgeted	Costs	Overtime	FY 2000
							0.0
							0.0
					1		0.0
							0.0
							0.0
							0.0
					-		0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal					0.0
		Subiolai		0.0	Pe	rsonnel Total	\$0.0
Travel Costs:	a an		Ticket	Round	Total	Daily	Proposed
Description		•	Price	Trips	Davs	Per Diem	FY 2000
······································				· · · · ·	-		0.0
							0.0
							0.0
							0.0
						-	0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
						Travel Total	0.0 \$0.0
				, 			φ0.0
	Project Number: 00327						FORM 3B
	Project Title: Digoon Gu	illemot Doc	toration Do	earch at the			Personnel
FYUU	Societo Contor		SUIGION RE	scaron at the	- Maska		& Travel
	Agency: DOI: ILS Ger	ological Su	nyav				DETAIL

Agency: DOI: U.S. Geological Survey

Prepared:

October 1, 1999 - September 30, 2000

<b>Contractual Cost</b>	is:		Proposed
Description			FY 2000
4A Linkage			160.6
When a non-truste	ee organization is used, the form 4A is required. Contrac	ctual Total	\$160.6
Commodities Co	sts:		Proposed
Description			FY 2000
	Commod	ities Total	\$0.0
	Project Number: 00327	FO	RM 3B
FY00	Project Title: Pigeon Guillemot Restoration Research at the Alaska	Contr	actual &
	Sealife Center	Com	modities
	Agency: DOI: U.S. Geological Survey		TAIL
Prepared:			

3 of 8

1

.

October 1, 1999 - September 30, 2000

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2000
			0.0
	}	]	0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
·			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.	New Equ	ipment Total	\$0.0
Existing Equipment Usage:		Number	Inventory
Description		of Units	Agency
	:		
· ·			
		·	
Project Number: 00327		F	ORM 3B
Project Title: Pigeon Guillemot Restoration Research at the	ne Alaska	E	auipment
Sealife Center			DETAIL
Agency: DOI: U.S. Geological Survey			

Prepared:

1

October 1, 1999 - September 30, 2000

Budget Category:	1 / duilonzou 1	Proposed			19 - 19 - 19 - 19 - 19 - 19 - 19 - 19 -	The line of the li		经济开	
<u> </u>	FY 1999	FY 2000							h. C.
									4
Personnel		\$33.3					- 15	- 44	
Travel		\$19.8				en anter de la companya de la company Recentra de la companya	a pressioner a	5 C	
Contractual		\$62.8							Tare .
Commodities		\$14.9	•			· · · ·		1	
Equipment		\$0.0		LONG F	RANGE FUNDI	NG REQUIRE	MENTS		
Subtotal	\$0.0	\$130.8			Estimated	Estimated			
ndirect		\$36.5			FY 2001	FY 2002			
Project Total	\$0.0	\$167.3							
					the second				
Full-time Equivalents (FTE)		1.3		4-1-1-1-1-4-4	A 1 44	Sel Transfer		an Section	6 S S
			Dollar amour	nts are shown	in thousands of	dollars.			
Other Resources									
Indirect rate for OSU is 42.5% 26% of MTDC off-campus res	of Modified Tota earch rate.	ll Dirct Cos <u>t</u> (I	/ITDC=Direct	cost- assistan	ceship and equ	ipment) on-ca	mpus rese	arch rate	and
Indirect rate for OSU is 42.5% 26% of MTDC off-campus res Not included in this budget is	of Modified Tota earch rate. cench fees for th	Il Dirct Cost (I	MTDC=Direct ∟ife Center.	cost- assistan	ceship and equ	iipment) on-ca	mpus rese	arch rate	and

ţ

October 1, 1999 - September 30, 2000

Per	sonnel Costs:			Months	Monthly		Proposed
	Name	Position Description		Budgeted	Costs	Overtime	FY 2000
: (	graduate research assistant	· ·		12.0	2.3		27.6
	research assistant, field			3.0	1.9		5.7
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
Nani							0.0
C. Salar			1				0.0
	• • • • • • • • • • • • • • • • • • •	Subtotal		15.0	4.2	0.0	
					Per	sonnel Total	\$33.3
Trav	vel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	<u></u>	Price	Trips	Days	Per Diem	FY 2000
	Corvallis, OR to Seward, Al	<	0.7	5			3.5
	Seward, AK to field sites for	egg collection	0.5	16	30	0.1	11.0
	presentation at Pacific Seat	bird Group meeting	0.5	3	10	0.1	2.5
(10) (10) H.S.	presntation at EVOS Restor	ation Workshop	0.6	3	10	0.1	2.8
							0.0
							0.0
							0.0
							0.0
18.0							0.0
1.4						·	0.0
							0.0
							0.0
			-			Travel Tota	\$19.8
		Project Number: 00327					FORM 4B
		Project Title: Pigeon Guillemot Re	storation Re	search at th	e Alaska		Personnel
		Sealife Center					& Travel

Agency: DOI: U.S. Geological Survey

.

Prepared:

6 of 8

DETAIL

1

October 1, 1999 - September 30, 2000

New Equipment Purchases:		Number	Unit	Proposed
Description		of Units	Price	FY 2000
				0.0
				0.0
				0.0
				0.0
				0.0
	· ·			0.0
				0.0
				0.0
				0.0
				0.0
·				0.0
				0.0
Those purchases associated with replacement ec	upment should be indicated by placement of an R	New Equ	ipment Total	\$0.0
Existing Equipment Usage:			Number	
Description			of Units	
<b></b>	······································			
· ·				
	· · · · · · · · · · · · · · · · · · ·			
				Addes and the
		<u> </u>	<u> </u>	
Project Num	per: 00327			
Project Title	Pigeon Guillemot Restoration Research at the Al	aska		
<b>FY00</b> Society Control		asna		quipment
				DETAIL
Agency: DO	I: U.S. Geological Survey		–	
Prepared:	· · · · · · · · · · · · · · · · · · ·		l	8

•

.

-

October 1, 1999 - September 30, 2000

<b>Contractual Cos</b>	is:		Proposed
Description			FY 2000
Personal Ser	vices Contract to George Divoky		35.0
Housing in S	eward for 3 persons (4 mo @75\$/day)		9.9
duplication/co	omputer fees		1.2
lab analyses	of blood and excreta samples for biomarkers (L. Duffy, UAF)		10.0
samples ship	ping		1.0
publication- r	eports and visual aids		1.5
vehicle renta	Anchorage to Seward		1.1
field equipme	nt maintenance		1.3
phone servic	es- long distance charges		1.8
	Cont	ractual Total	\$62.8
Commodities Co	sts:		Proposed
Description			FY 2000
cages for chi	cks raised in captivity		0.5
nest boxes, a	inticial nest sites		1.7
decoys, playl	backs, other social attractants		1.6
egg collecting	g equipment		0.6
incubators			0.3
blood sample	collection supplies		2.5
food for pers	onnel at Seward (3 persons, 16 wk@\$200/wk)		4.5
Ohaus top-lo	ading balance, battery-powered		2.2
food for chick	is · · ·		0.4
bands and ba	anding supplies		0.6
miscellaneou	s supplies for captive rearing		
	Commo	odities Total	\$14.9
		<b>r</b>	
	Project Number: 00327		ORM 4B
EVAA	Project Title: Pigeon Guillemot Restoration Research at the Alaska	Cor	ntractual &
FIUU	Sealife Center	Co	mmodities
	Agency DOL LLO Opplanized Oversey		
	Agency: DOI: U.S. Geological Survey		

Prepared:

L

.

00330

#### Project Title: Mass-Balance Model of Trophic Fluxes in Prince William Sound - Closeout

Project Number:	00330
Restoration Category:	Ecosystem Synthesis
Proposer:	Daniel Pauly, Fisheries Centre, University of British Columbia
Primary Contact:	Thomas A. Okey, UBC Fisheries Centre, tokey@fisheries.com
Lead Trustee Agency:	NOAA
Alaska Sea Life Center:	no
Duration:	closeout months of two year project
Cost FY 00:	\$ 27,767
Cost FY 01:	\$ 00,000
Geographic Area:	Prince William Sound
Injured Resource/Service:	All injured biological resources and all damaged services

#### ABSTRACT

Closeout funding is requested for this two-year ecosystem synthesis during which a food-web model of Prince William Sound (PWS) was constructed, refined, and initially disseminated. This mass-balance model of trophic flows in the Prince William Sound food web was presented at the 16<sup>th</sup> Lowell Wakefield fisheries symposium in 1998 and at the 10<sup>th</sup> annual EVOS Restoration workshop in March of 1999. The PWS food web model also forms the core of a prototype CD ROM, distributed to experts, educators, and the public for review. This CD ROM also includes food web models from three other aquatic ecosystems of Alaska, user-friendly databases on the biology and local/traditional knowledge of the marine organisms of the PWS area, and links to related information and resource agencies. Closeout funding is requested for three purposes: (1) to produce a final version of the CD ROM and distribute it to resource managers, schools, communities, and the general public; (2) to provide hands-on guidance and education on food web based management approaches to resource managers and other potential users; and (3) for publishing several reports and articles in peer-reviewed scientific journals, which are currently planned, in preparation, or under review.


# INTRODUCTION

The purpose of this project, *Mass Balance Model of Trophic Fluxes in Prince William Sound* (BAA-330), is to synthesize ecosystem information collected since the 1989 EVOS. A computer model of the PWS food web was constructed with empirically-based estimates resulting from the EVOS research program. The purpose of constructing this model was to address system-wide questions, build a cohesive picture of the structure and flows of the biotic portion of the ecosystem, and enable ecosystem-based assessment and management of the natural resources of PWS. The model was constructed with the widely-used Ecopath software (Christensen and Pauly 1992a, b, 1995, 1998, Pauly and Christensen 1993, Pauly and Christensen 1995, and other authors in Christensen and Pauly 1996). The model has undergone refinement, and it has been presented to scientists and resource managers and disseminated to a broader audience of educators and the general public in Alaska. The following lists summarize our accomplishments:

### **Completed Objectives**

- Prepared and held a one-week model specification workshop;
- Built a food web model of the interactions of the APEX community members;
- Built a food web model of the interactions of the NVP community members;
- Built a food web model of the interactions of the SEA community members;
- Integrated the three food webs into two, large-scale models of the interactions of the communities;
- Interacted with experts and modify Ecopath mass-balance model until consensus on trophic interactions in PWS and adjacent waters is reached;
- Entered biological information, local names in local languages, and local knowledge (so far published) on PWS region fishes and other Alaskan fishes into FishBase;
- Linked the Ecosim module of the PWS model with an existing model of PWS capable of predicting primary production, and thus drive the trophic interactions in Ecosim;
- Prepared a CD-ROM with Ecopath/Ecosim model(s) of PWS, and a database on the fishes of the PWS region;
- Presented the project and its products at every opportunity, especially at conferences and in the primary literature.
- Enabled the models to be run in a spatially-explicit manner using Ecospace by expressing spatial distributions of organisms.

# **Objectives still in preparation**

- Prepare and hold a workshop to present and disseminate the CD ROM product, and teach its use;
- Modify PWS Ecopath model such that seasonal changes are explicitly considered when establishing mass balance;

### **Objective deleted during FY99 contract refinement**

• Use essentially the same method to construct an Ecopath model of the Kenai Shelf and the Outer Cook Inlet;

# Project Milestones and Endpoints for FY99 (progress to date)

Nov. 1998:	Incorporation of explicit seasonally into PWS Ecopath Model and submission of
	scientific paper on subject (Martell et al., in prep.);
Jan. 1999:	Holding of Model Specification Workshop (task deleted; see above);
Mar. 1999:	Presentation of results at EVOS 10 year legacy conference (completed);
May. 1999:	Publication of Shelf model report (task deleted; see above);
Jun. 1999:	Submittal of scientific papers documenting key features and behavior of trophic
	mass-balance models including Ecospace paper (Okey and Pauly, in press.;
	Okey et al., in prep.; Martell et al., in prep.; Hulbert et al. in prep.; Purcell et
	al. in prep.; also see Okey and Pauly 1998, 1999);
Sep. 1999:	Final dissemination of project results and products

The overall project is on schedule, even though one task (seasonal model) was shifted from November 1998 to summer 1999. In fact, this project will likely result in several more scientific papers than were originally expected (e.g., see list above).

By working with the various experts, we achieved a broad and inclusive ecosystem synthesis of the larger Prince William Sound and insights into the changes within it. This broad participation, and the collaborative process complimented existing EVOS research and provided ecosystemlevel insights into both the structure and function of PWS and the effects of EVOS and other perturbations. The Prince William Sound Ecopath model is described in detail by the various contributors in Okey and Pauly (1998 and 1999) and the collaborative approach used to create it, as well as some epistemological implications of this approach, are described in Okey and Pauly (in press.).

# NEED FOR THE PROJECT

# A. Statement of Problem

See the FY99 proposal for a statement on the need and usefulness of an integrated, ecological approach involving Ecopath modelling. This section describes the need for the three proposed closeout tasks listed under Objectives in the Project Design section.

*CD ROM of Alaska's Aquatic Ecosystems.* – The initial success of the prototype CD ROM we distributed in Anchorage and Seward during the past month lends credence to the notion that such a CD ROM is an ideal vehicle with which to disseminate the results of this synthesis of EVOS-generated ecosystem information. We received very positive feedback from attendees of the Legacy of an Oil Spill Symposium, from researchers at the Alaska Sealife Center (where the acting director of education is interested in building an interactive kiosk using the PWS model where visitors can perform simulations; Jim Pfeiffenberger, Alaska Sealife Center, personal communication), and from representatives of public schools (Jennifer Childress, Chugach School District, personal communication), private educational providers (Leslie Hines, Kenai Fjords Tours, personal communication), resource management agencies (Joe Sullivan, Alaska Department of Fish and Game, personal communication), native educational and research

Prepared: 12 April 1999

organizations (Robert Patrick, Aleutian / Pribilof Islands Association, personal communication), an interagency library (Carrie Holba, ARLIS library, personal communication). These are a few examples of cases in which this CD ROM is being considered for use. Furthermore, program developers of the native organization Chugachmiut consider this CD ROM to be ideal for their educational programs (Sandy Wasilli, Chugachmiut, personal communication), and they will begin using it right away, even before the final version of the CD ROM is available.

Production of the prototype CD ROM required the full funding budgeted for this item in FY99. We are already receiving feedback that will guide us through refinements to produce an excellent product, and it appears that it would be widely used given additional funding to enhance the product for research and educational purposes. We believe that we and the EVOS trustees have an excellent opportunity to bring some synthesized EVOS results together with students, communities, and resource managers and planners.

*Guidance for resource managers and other users.* – The opportunity presented by the results of this ecosystem synthesis program will be realized through the use of the Prince William Sound model in management and educational situations, whether or not the CD ROM is the main vehicle for dissemination. The PWS model and the accompanying Ecopath/Ecosim/Ecospace software provides a useful tool for ecosystem-based management that compliments the toolbox currently used by fishery managers. However, inertia and skepticism will likely prevail until managers become familiar with the potential uses of the approach (Mundy and Gunther 1999, and Philip Mundy, Fisheries and Aquatic Sciences, pers. comm.). A number of individuals have been shown this approach in person and at the workshops held over the previous year.

The objective of preparing and holding a workshop to present and disseminate the CD ROM product and teach its use (objective 11: EVOS restoration proposal 99330) has been partially accomplished through four venues: the 16<sup>th</sup> Lowell Wakefield Symposium, the Legacy of an Oil Spill Symposium, one-on-one training sessions with interested individuals, and the 5 October 1998 workshop in Anchorage (Okey and Pauly 1998, 1999). Additional workshops for resource managers would provide additional opportunities for agencies to adopt this approach as a compliment to managing exploitation of the living resources in their trust. Although it is a challenging task to persuade managers to adopt new methods, it is worthwhile to provide guidance and educational outreach on the Ecopath approach (Phillip Mundy, Fisheries and Aquatic Sciences, pers. comm.). This is especially true given widespread calls for instituting approaches for ecosystem-based management (NMFS 1999; Keller, in press.).

A budgetary oversight was made by the project coordinator for 99330 (Thomas Okey) in failing to propose travel costs for this objective in the FY99 budget. Furthermore, it is unlikely that left-over funds from 99330 will be available for this task based on an up-to-date analysis (Ann Tautz, UBC Fisheries Centre Administrator, pers. comm., 9 April 1999). Options to remedy this situation include addition of the travel costs for a workshop in an FY00 budget (see attached budget), and utilization of funds from EVOS synthesis project 300 (Andy Gunther, Applied Marine Sciences, pers. comm., 12 April 1999). Considering the interest that has developed in the CD ROM product, including the PWS Ecopath model, within certain sectors of the educational and NGO communities (see above), it is possible, and may be worthwhile, to conduct a workshop tailored to these communities in addition to the workshop for the resource management communities. Use of the CD ROM and model by these public-user sectors has the potential to influence rates of acceptance by resource management agencies.

*Manuscript preparation and publication.* – Two publications have already resulted from this synthesis project (Okey and Pauly 1998, and In press). Several more publications are in preparation, and others have been conceptualized (see Publications and Reports section below). This project has resulted in good opportunities for publications by contributors to the model because of insights revealed through this approach to ecosystem synthesis. However, these opportunities will be under-exploited without closeout funds for project staff to catalyze publication ideas and continue to guide this successful collaborative process. We are aware that the trustee council may contribute 1.5 months of personnel time per manuscript plus \$1,000 in page costs per project in order to ensure that information is disseminated. However, we are not requesting funding explicitly for this purpose at this time, in order to keep our current request small, and with the assumption that we will be able to lend some focus to these manuscripts given the closeout funding requested herein.

# B. Rationale / Link to Restoration

See the FY99 proposal for a general discussion on rational for applying a collaborative version of the Ecopath approach in the Prince William Sound setting. The rational for the current request is to ensure that results are optimally presented and disseminated.

# C. Location

The area covered by the Ecopath model is Prince William Sound. The CD ROM of Alaska's Aquatic Ecosystems includes Ecopath models of the Bering Sea, the Alaska Gyre, and Lake Becharof in addition to Prince William Sound. Other resources on the CD ROM, such as Alaska Fishbase, links to other programs, and the Alutiiq dictionary, cover broader areas of Alaska. Distribution of the final CD ROM will be focused on the south-central region of Alaska.

# COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Native organizations of the Prince William Sound Region such as Chugachmiut are very interested in using the CD ROMs in their educational programs (Sandy Wasilli, personal communication; also see Statement of Problem above). These and other organizations are particularly interested in the TEK resources that have been included on the CD ROM. They are not only interested in using our product, but they have interest in making further contributions to it as we move towards the final version. School teachers and educational program administrators have also expressed interest in this product for their science education programs. We believe that this analytical tool (the PWS Ecopath model) and the accompanying CD ROM can ultimately result in communities having a more direct involvement in managing exploitation of natural resources within state and federal science and management structures, as this approach provides a functional conduit for multi-directional flows of ecosystem knowledge.

# **PROJECT DESIGN**

# A. Objectives

Three closeout tasks are proposed for this final period:

- 1. Produce a final CD ROM product for the public domain including resource managers and educational purposes. Refinements will be based on feedback from the completed distribution of the prototype CD ROM;
- 2. Provide hands-on guidance and education on the Ecopath approach to resource managers and other potential users (implementing objective 11 identified in 99330); and
- 3. Publish several articles in peer-reviewed scientific journals and reports, which are currently planned, in preparation, in review, or in press.

### **B.** Methods

Refer to our FY98 and FY99 project proposals for specific methodologies of developing an ECOPATH model. The following paragraphs focus on the basic methods of accomplishing the closeout tasks specified in the introduction section of the current proposal.

*CD ROM of Alaska's Aquatic Ecosystems* - The prototype CD-ROM, *Alaska's Aquatic Ecosystems*, has been produced and was distributed to resource managers, researchers, educators, and community organizations over the last month (see Introduction). It is a vehicle for much of the work in this project including the working PWS EcoPATH model including EcosIM and ECOSPACE, databases of Alaskan fishes, a native language dictionary of terms related to the PWS ecosystem, and other related resources. This CD-ROM was completed in time for the 10<sup>th</sup> annual EVOS workshop as proposed with all the planned components (see FY99 proposal and attached CD ROM).

Production of a final CD ROM product will be accomplished by incorporating feedback from the initial round of CD ROM distribution. We have already begun receiving feedback on the prototype version and we are looking forward to building a product that will be even easier to use, and one that is enhanced with more photographs, videos, web resources, and educational features. This will involve design refinements and active networking in addition to incorporation of feedback. A student intern will be employed for two months to gather and organize the information and electronic components to be included on the final CD ROM, under supervision. A computer media production specialist will then be employed for two months to conduct final construction and refinements to the prototype CD ROM. This is a similar process to that used for construction of the prototype version.

The University of Alaska Sea Grant has expressed interest in helping to distribute the final CD ROM (Brenda Baxter, pers. comm., February 1999), and the EVOS restoration office could also serve as a conduit for distribution to investigators, agencies, and other interested parties through the restoration newsletter (Stan Senner, pers. comm., 9 April 1999). Opportunistic exploratory research on the interest of school districts and educational organizations would also be conducted.

*Guidance for resource managers and other users* – There will be opportunities to organize a workshop for the purpose of introducing professional resource managers to the Prince William

Prepared: 12 April 1999

Project 00330

Sound model and the Ecopath approach. This may lead to the adoption this tool by managers who wish to compliment their assessment and management methods with an approach to ecosystem-based management. Potential participating agencies and individuals will be contacted, and a training workshop will be held during the fall or winter of 1999 / 2000. Both the PI and the project coordinator will conduct this workshop, with the cooperation of other interested program personnel. (e.g., Philip Mundy, Andy Gunther, etc.). Certain funding alternatives (see Statement of Problem) may enable such a workshop to be conducted during summer of 1999, however, this will depend on the travel schedules of individuals involved.

*Manuscript preparation and publication* – Project staff will continue working collaboratively with model contributors to finish manuscripts that have been started, and to identify other insights about Prince William Sound revealed by the model, which are worth pursuing as publications. The UBC project staff will provide organizational leadership for manuscripts in cases where contributing researchers have limited time.

# SCHEDULE

### A. Measurable Project tasks for FY 00

October 1999:	Produce and distribute final CD ROM with PWS model, etc.
Fall/Winter 1999:	Training workshop for interested agency(ies)
Summer 1999 / Summer 2000:	Submittal and publication of manuscripts

#### **B.** Project Milestones and Endpoints

Closeout Milestones (in addition to required annual reports):

October 1999:	Produce and distribute final CD ROM with PWS model, etc.
Fall/Winter 1999:	Possible training workshop for interested agency(ies)
July 1999:	Submission of: Okey et al. (in prep) to Ecological Applications
August 1999:	Submission of: Martell et al. (in prep) to Ecological Modeling
November 1999:	Submission of: Hulbert et al. (in prep)
February 1999:	Submission of: Purcell et al. (in prep)

### C. Completion Date

Most tasks will be complete before the end of 1999, but we expect that some manuscripts will not be submitted until summer of the year 2000.

# **PUBLICATIONS AND REPORTS**

- Hulbert, L., K. Y. Aydin, B. A. Wright, and T. A. Okey. In prep. Ecological implications of increasing shark populations in PWS: simulations using an Ecopath model. Target Journal: ?
- Martell, S., T. A. Okey, C. J. Walters, T. Pitcher and D. Pauly. In prep. A seasonally-explicit model of Prince William Sound, Alaska. Target Journal: Ecological Modelling

- Okey, T. A. and D. Pauly, (eds.). 1998. A Trophic Mass-Balance Model of Alaska's Prince William Sound Ecosystem, for the Post-Spill Period 1994-1996. Fisheries Centre Research Report 6(4), University of British Columbia, Vancouver, Canada. 144 p.
- Okey, T. A. and D. Pauly, (eds.). 1999. A Trophic Mass-Balance Model of Alaska's Prince William Sound Ecosystem, for the Post-Spill Period 1994-1996. Exxon Valdex Oil Spill Restoration Project Annual Report (Restoration Project 98330), Fisheries Centre, University of British Columbia, Vancouver, Canada. 144 p.
- Okey, T. A. and D. Pauly. In press. A mass-balanced model of trophic flows in Prince William Sound: decompartmentalizing ecosystem knowledge. *In:* S. Keller (ed.), Ecosystem Approaches for Fisheries Management, University of Alaska Sea Grant, AK-SG-99-01, Fairbanks.
- Okey, T. A., T. A. Dean, T. Cooney, R. J. Foy, J. Bodkin, and D. Pauly. In prep. Trophic cascades in the Prince William Sound Ecopath model: revelations or artifacts? Target journal: Ecological Applications
- Purcell, J. E. and T. A. Okey. In prep. Simulations of zooplanktivore populations using an Ecopath model: forage fish versus jellyfish in Prince William Sound, Alaska. Target journal: Marine Ecology Progress Series

# **PROFESSIONAL CONFERENCES**

The results of this ongoing project have been presented at the following symposia:

- Legacy of an Oil Spill Symposium: 10 years after the Exxon Valdez. 1999. "The food web of Prince William Sound: an Ecopath toward ecosystem-based management."
- 16<sup>th</sup> Lowell Wakefield Fisheries Symposium; Ecosystem Considerations in Fisheries Management. 1998. "A mass-balance model of trophic flows in Prince William Sound"

In addition to the presentations listed above, several workshops were conducted during the course of the work (see previous proposals) and additional training workshop(s) are planned in the current proposal. Presentations of this work at additional professional conferences is likely, as publications continue to spin off from this project. However, no funding is currently requested for this purpose.

# COORDINATION AND INTEGRATION OF RESTORATION EFFORTS

The aim of the proposed work is to synthesize data from projects funded by the Trustee council and to disseminate results to resource managers, and for educational purposes. The PWS Ecopath model resulted from a broad collaborative effort across numerous agencies (Okey and Pauly 1998, 1999, in press).

# **EXPLANATION OF CHANGES IN CONTINUING PROJECTS**

We were successful in producing a refined Ecopath model of PWS (Okey and Pauly 1998, 1999, in press) and a prototype CD ROM for distribution of the model and software to interested and appropriate parties. Funds are needed to carry this work through to a successful completion by

providing the means to disseminate the results of the project including a final version of the CD ROM and publications in peer-reviewed scientific journals.

# PROPOSED PRINCIPAL INVESTIGATOR

Dr Daniel Pauly Professor, Fisheries Centre, University of British Columbia 2204 Main Mall, Vancouver, B.C. Canada, V6T IZ4 (604) 822-1201 (604) 822-8934 (fax) E-mail: pauly@fisheries.com

# **PROJECT COORDINATOR (and principal contact)**

Thomas A. Okey, M.S. Marine Ecologist, Fisheries Centre, University of British Columbia 2204 Main Mall, Vancouver, B.C. Canada, V6T IZ4 (604) 822-1950 (604) 822-8934 (fax) E-mail: tokey@fisheries.com Web Page: http://fisheries.com/members/tomokey.htm

# PRINCIPAL INVESTIGATOR

**Dr. Daniel Pauly** - The key qualifications of Dr. Pauly are having initiated, while still at ICLARM, Manila, Philippines, the activities which led to the emergence of the Ecopath approach and software, and of FishBase, and to have authored a large number of primary literature publications documenting these. Further, he has organized several workshops (including one in the Pacific Northwest) and training courses at which the Ecopath approach was taught and used.

### **OTHER KEY PERSONNEL**

Thomas A. Okey, M.S., Project Coordinator / Marine Ecologist, Fisheries Centre, UBC, who will coordinate the development and distribution of the final CD ROM, the Ecopath training sessions for interested agencies, and resulting papers and reports.

Cindy Young, Multi-media Production Specialist, Department of Zoology, UBC, who produced the prototype CD ROM and will produce the final version.

#### LITERATURE CITED

- Abrams. 1992. Predators that benefit prey and prey that harm predators. Unusual effects of interacting foraging adaptations. American Naturalist 140: 573-600.
- Christensen, V. and D. Pauly (eds.) 1994. Trophic Models of Aquatic Ecosystems. ICLARM Conference Proceedings. 26, 390 p.
- Christensen, V. and D. Pauly 1992a. ECOPATH II A system for balancing steady-state ecosystem models and calculating network characteristics. Ecol. Modelling 61:169-185.
- Christensen, V. and D. Pauly 1992b. A guide to the ECOPATH II software system (version. 2.1). ICLARM Software 6. 72 p.
- Christensen, V. and D. Pauly. 1998. Changes in models of aquatic ecosystems approaching carrying capacity. Ecological Applications 8(1):S104-S109.
- Dalsgaard, J. and D. Pauly. 1997. Preliminary Mass-Balance Model of Prince William Sound, Alaska, for the Pre-Spill Period, 1980-1989. *Fisheries Centre Research Reports*. 5(2), 33 p.
- EVOS Trustee Council. 1996. Invitation to submit restoration proposals for federal fiscal year 1997. *Exxon Valdez* Oil Spill Trustee Council, Anchorage.
- Hulbert, L., K. Y. Aydin, B. A. Wright, and T. A. Okey. Ecological implications of increasing shark populations in PWS: simulations using an Ecopath model. (in prep.).
- Keller, S. (ed.). In press. Ecosystem Approaches for Fisheries Management, University of Alaska Sea Grant, AK-SG-99-01, Fairbanks, Alaska.
- Ludwig, D., R. Hilborn, and C. J. Walters. 1993. Uncertainty, resource exploitation, and conservation: Lessons from history. Science 260: 17, 36.
- MacCall, R. A. and R. M. May. 1995. More than a seafood platter. Nature 376: 735.
- Martell, S., T. A. Okey, C. J. Walters, T. Pitcher and D. Pauly. A seasonally-explicit model of Prince William Sound, Alaska. (In prep.) Target journal: Ecological Modelling
- Mundy, P. R. and A. J. Gunther. 1999. A synthesis of fisheries investigations for restoration of injury from the Exxon Valdez oil spill. Legacy of an oil spill: ten years after Exxon Valdez: Abstracts, March 23-26, 1999. Exxon Valdez Oil Spill Trustee Council, Alaska Department of Fish and Game, Anchorage, Alaska, p. 21.
- NMFS. 1999. Ecosystem-based fishery management: a report to congress by the Ecosystem Principles Advisory Panel. NOAA Technical Memorandum NMFS-F/SPO-33. NMFS, Silver Spring, Md.
- Okey, T. A. and D. Pauly, (Eds.). 1998. A Trophic Mass-Balance Model of Alaska's Prince William Sound Ecosystem, for the Post-Spill Period 1994-1996. Fisheries Centre Research Report 6(4), University of British Columbia, Vancouver, Canada. 144 p.
- Okey, T. A. and D. Pauly, (Eds.). 1999. A Trophic Mass-Balance Model of Alaska's Prince William Sound Ecosystem, for the Post-Spill Period 1994-1996. Exxon Valdex Oil Spill Restoration Project Annual Report (Restoration Project 98330) Fisheries Centre, University of British Columbia, Vancouver, Canada. 144 p.
- Okey, T. A. and D. Pauly. In press. A mass-balanced model of trophic flows in Prince William Sound: decompartmentalizing ecosystem knowledge. *In:* S. Keller (Ed.), Ecosystem

Approaches for Fisheries Management, University of Alaska Sea Grant, AK-SG-99-01, Fairbanks.

- Okey, T. A., T. A. Dean, T. Cooney, R. J. Foy, J. Bodkin, and D. Pauly. In prep. Trophic cascades in the Prince William Sound Ecopath model: revelations or artifacts? Target journal: Ecological Applications
- Pauly, D. and V. Christensen 1993. Stratified models of large marine ecosystems: a general approach and an application to the South China Sea, p. 148-174. *In* K. Sherman, L.M. Alexander and B.D. Gold (editors). Stress, mitigation and sustainability of large marine ecosystems. AAAS Press, Washington,
- Pauly, D., and V. Christensen (eds.). 1996. Mass-balance models of North-eastern Pacific ecosystems. Fisheries Centre University of British Columbia, Vancouver, 131 p.
- Pimm, S. L., J. H. Lawton, and J. E. Cohen. 1991. Food webs patterns and their consequences. Nature 350: 669-674.
- Pimm, S.L. 1984. The complexity and stability of ecosystems. Nature 307: 321-326.
- Polovina, J. J. 1984. Models of a coral reef ecosystem I: the ECOPATH model and its application to French Frigate Schoals. Coral Reefs 3(1):1-11.
- Purcell, J. E. and T. A. Okey. Simulations of zooplanktivore populations using an Ecopath model: forage fish versus jellyfish in Prince William Sound, Alaska. (In prep.) Target Journal: Marine Ecology Progress Series.
- Springer, A. 1992. Walleye Pollock: How much difference do they really make? Fisheries Oceanography 1: 80-96.
- Vanni, M. J. 1987a. Effects of food availability and fish predation on a zooplankton community. Ecological Monographs 57; 67-88.
- Vanni, M. J. 1987b. Effects of nutrients and zooplankton size on the structure of a phytoplankton community. Ecology 68: 624-635.
- Walters, C., V. Christensen and D. Pauly. 1997. Structuring dynamic models of exploited ecosystems from trophic mass-balance assessments. Reviews in Fish Biology and Fisheries 7: 139-172.

# FY 00 EXXON VALDEZ TRU: COUNCIL PROJECT BUDGETOctober 1, 1999 - September 30, 2000

							<u> </u>	
	Authorized	Proposed		130 - 18 20 20				and the second
Budget Category:	FY 1999	FY 2000						
			1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1				n a s An air an s	
Personnel	\$89,500	\$18,150		No.	1000 1000 1000		A gradina in	an a
Travel	\$10,090	\$2,440	· 爱云气的 要求 医血液	11 : 11 : 11 : 11 : 11 : 11 : 11 : 11		a si da da		9 V6 G.
Contractual	\$15,000	\$1,643	- 御台送 金属市 人名			n i se konstante istore		(1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,
Commodities	\$0	\$0		신 나는				and the particular sector
Equipment	\$400	\$0	LON	IG R/	ANGE FUNDI	NG REQUIRE	MENTS	
Subtotal	\$114,990	\$22,233	Estimat	ed	Estimated	Estimated		
Indirect	\$25,011	\$5,534	FY 200	)1	FY 2002	FY 2003		
Project Total	\$140,001	\$27,767	\$	0.0	\$0.0	\$0.0		
			1. 法法律法法法 南方	19		s ê s		
Full-time Equivalents (FTE)	21.1	6.5					an a	
			Dollar amounts are sho	wn ir	thousands of	dollars.		
Other Resources								
Comments:								
government and NGOs' of 30% *The second line item under 'tra project coordinator paid for by a interactive kiosk in which visitor	of the cost of p ivel costs' is no inother entity. F s could perform	bersonnel and t included in t For example, a n simulations t	2% or travel costs. he totals. This line item r trip could be taken to a using the PWS model ar	epres ssist d Ec	sents projecte the Alaska Se osim.	d costs for and a Live Center	other trip to <i>i</i>	Alaska for the
FY 00	Project Nur Project Title Prince Willi Name: Fis	nber: 330 e: Closeout am Sound heries Cent	of Mass-Balance Mo re UBC	odel	of Trophic F	-luxes in		FORM 4A Non-Trustee SUMMARY

# FY 00 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Pers	sonnel Costs:			Months	Monthly		Proposed			
	Name	Position Description		Budgeted	Costs	Overtime	FY 1999			
	Dr. Daniel Pauly	PI - UBC Fisheries Centre		0.5	7500		3,750			
	Thomas A. Okey, MS	Project Coordinator- UBC Fisheries Centre		2.0	4200		8,400			
	Cindy Young	Computer Media Production Specialist		2.0	2000		4,000			
	(to be appointed)	graduate student - Pauly		2.0	1000		2,000			
17 - F 4 12 - F							0			
							0			
							0			
							0			
							0			
х. , с							0			
- D							· 0			
							0			
		Subtotal		6.5	14700.0	0.0				
					Per	sonnel Total	18,150			
Travel Costs:			Ticket	Round	Total	Daily	Proposed			
Description			Price	Trips	Days	Per Diem	FY 1999			
UBC PI and project coordinator to possible training workshop			700	2	8	130	2,440			
	(UBC proj. coord. meet educators, communities, and managers)*			1	10	130	2,000			
à.						130	0			
e de L							0			
							0			
							0			
							0			
							0			
							0			
							0			
							0			
						Travel Total	2 440			
ر <b>ل</b> ـــــــــ							2,110			
		Ducia at Numericano 220								
.		Project Number: 330	<b>.</b>							
	FY 00	Project Title: Closeout of Mass-Bal	ance Model	of Trophic F	luxes in	4	rersonnel			
		Prince William Sound					& Travel			
		Name: Fisheries Centre UBC					DETAIL			
Prep	/repared: 9 April 1999									

-

# FY 00 EXXON VALDEZ TRU: COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:		Proposed
Description		FY 1999
Production of final CI	D-Rom Alaska's Aquatic Ecosystems	
Production of 10	000 CD ROMs with silkscreen design	891
Four color CD b	ooklet and tray card	165
Four color film		132
Shipping from pi	rinters	165
Digitizing video a	and slides	158
Cost of art produ	uction (included in Cindy's salary)	0
Distribution Costs		132
		0
	Contractual Total	1,643
<b>Commodities</b> Costs	6:	Proposed
Description		FY 1999
· ·	•	
	·	
	· · · · · · · · · · · · · · · · · · ·	
L	Commodities Total	\$0.0
j	Project Number, 220	ORM 4B
	Project Number: 330	Intractual &
FY 00	Project Title: Closeout of Mass-Balance Model of Trophic Fluxes in	mmodifies
	Prince William Sound	
	Name: Fisheries Centre UBC	DETAIL

Prepared: 9 April 1999

# FY 00 EXXON VALDEZ TRU

October 1, 1999 - September 30, 2000

New Equipment	Purchases:	Number	Unit	Proposed
Description		of Units	Price	FY 1999
				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 Equ	lipment Total	\$0.0
Existing Equipme	nt Lisade.		Number	+
Description			of Units	
				1
				· · · · ·
l			L	
	Broject Number: 220			
	Project Nulliber, 550		1   -	
FY 00		-iuxes in		quipment
	Prince William Sound			DETAIL
	Name: Fisheries Centre UBC		L	

Prepared: 9 April 1999

:

00333 · . .

. ~~

•

0333

# Native Village of Eyak P.O. Box 1388

P.O. Box 1388 Cordova, AK 99574 907-424-7738 Fax 907-424-7739

April 15, 1999

Molly McCammon, Executive Director Exxon Valdez Oil Spill Trustee Council 645 G Street, Suite 401 Anchorage, AK 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. The cause is unclear to many of our Tribal members. As this is a recent phenomenon, we need to study this to find out what is the cause of their deaths.

As a Tribal Council, we are requesting technical assistance from EVOS for this proposal.

Sincerely yours

Bob Henrichs President Native Village of Eyak Traditional Council



# Sea Otter Monitoring Project

Project Number:	00333
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 00:	\$261.9
Cost FY 01:	\$275.0
Cost FY 02:	\$288.7
Cost FY 03	\$303.2
Cost FY 04:	\$318.3
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 is something new. We need to do some monitoring of this to find out what is causing this.



Native Village of Eyak Exxon Valdez Oš Spili Trustees Council Sea Otter Monitoring Project Budget Summary

Budget Category	Authorized FY 99	Proposed FY DO				
Personnel		146,899				
Travel		5,208				
Contractual		18,000				
Commodities		15,702	Lo	ng Range Funding	Requirements	
Equipment		19,199				
Other		4,500				
Subtotal		209,508	Estimated	Estimated	Estimated	Estimated
Indirect		52,377	FY 2001	FY 2002	FY 2003	FY 2004
Budget Total	D	261,885	274,979	288,725	909,161	318,319
Full-Time Equivalent (FT)	E)	3.0	4,00	4.00	4,00	4.00

Native Valage of Eyak
Exxon Valdez Od Spill Trustees Council
Sea Otter Monitoring Project
Dustant Detail Marretine

<u>Salaries:</u>		Budget	Detall Narradive	Proposed FY 00	2001	2002	2003	2004
Project Lead Biologist	The project lead biologist will v prepare data gathering plan ar	vork to research past tren nd implement project.	ds on Sea Otter Populations and					
	Project Biologist:	1 FTE Ø	70,500	70,500	74,025 (1 FTE)	77,726 (1 FTE)	81,512 (1 FTE)	85,693 (1 FTE)
Fisheries Technicians	Two research technicians will be needed to assist with the design and implementation of the project for 6 months per year.			, , , , , <u>, , , , , , , , , , , , , , </u>	(••••=)		(,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	(····-)
	Fisherics Technicians	1 FTE @	39,950	39,950 (1 FTE)	41,948 (1 FTE)	44,045 (1 FTE)	46,247 (1 FTE)	48,559 (1 FTE)
Total Salaries				110,450	115,973	121,771	127,859	134,252

. . . .

.

· · · · ·

.

and the second

ورفاسه والافتار الارار

Fringe:

FICA

6.20%

Medicare	1.45%					
FUTA	0.60%					
Alaska ESC	3.50%					
Workman's Comp.	5.25%					
Medical, Dental Vision benefits	16.00%	Proposed FY 00	2001	2002	2003	2004
Budgeted Fringe:	33.00% of salary.	36,449	38,271	40,184	42,193	44,303
Budgeted Personnel		145,899	154,244	161,965	170,052	178,555

#### Travel;

3

.

 Travel will be needed to gather to discuss the project and prepare the restoration plan and implement the work

	. –		Proposed FY 00	2001	2002	2003	2004
Lead Biologist Travel to meetings, and protessional or Research Technician Travel to conduct project Council Travel and Public Involvement Hearings	nterences		6752 2,043 3,165				
Budgeted Travel:			5,208	5,468	5,741	6,028	6,329
<u>Contractual</u>	Hours	Cost/Hr.	Proposed FY 00	2001	2002	2009	2004
Scientific review and consultation on planning and project design	100	85	8,500	8,925	9,371	9,840	10,932
Vessel Charler	100	95	9,500	9,975	10,474	10,998	11,545
Sudgeted Contractua):	~		18,000	18,900	19,845	20,838	21,880
Commodities:							
Supplies will be needed to accomplish the project. Of presentation media will be required to track data and p	ice supplies, filing suppl roject information, produ	ies, and sols and malerials.					
	Cost Per Month	Months Needed	Proposed FY 00	2001	2002	2003	2004
Office Supplies, filing, data and other.	162	12	1,944	2,041	2,143	2,250	2,363
Project Field Supplies, Tags and Materials	2,293	6	13,758	14,446	15,168	15,926	16,722

. . . . . . . . . . .

و المحر

P

ه بدورسر و

• •

الأحام والمحاج والمحاجة المواريات المتحور والمار والمحاور والمحاج

. . . . . . .

Budgeted Commodities:			15,702	16,487	17,311	18,176	19,085
Equipment:							
			Proposed FY 00	2001	2002	2003	2004
Testing and monitoring recording devices, lab and meas	urement equipment		12,963	13,611	14,292	15,007	15,757
Computer Equipment			6,235	6,548	6,875	7,219	7,580
Budgeted Equipment:			19,199	20,159	21,167	22,22 <del>8</del>	23,337
Other:							
	Cost Per Monih	Months Needed	Proposed FY 00	2001	2002	2003	2004
Phone, lax, copies, office and lab space	375	12	4,500	4,725	4,961	5,209	5,469
Budgeted Other:			4,500	4,725	4,961	5,209	5,469
Total Direct Costs:			209,508	219,983	230,980	242,529	254,655
indirect:							
indired is computed at our negotiated rate of 25%.			Proposed FY 00	2001	2002	2003	2004
Budgeted Indirect Costs:			52,377	54,996	57,745	60,632	63,654
Total Costs			261,835	274,979	268,725	303,167	315,319

. .

.. . .

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

Project Number:	00338	
Restoration Category:	Research	
Proposed By:	U.S. Geological Survey (PI- Joh	m F. Piatt)
Lead Trustee Agency:	DOI-BRD	
Cooperating Agencies:	DOI-FWS	
Alaska SeaLife Center	no	
Duration:	3 <sup>rd</sup> year, 4-year project	EXXUM VALDEZ OIL SPILL
Cost FY 00:	\$59,700	TRUSTEE COUNCIL
Cost FY 01	\$46,400 (data analysis, reporting	g)
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. Current APEX studies are 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 propose to determine 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 (Fig. 1) currently being investigated by 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 (Fig. 2). This difference appears to be manifested in sharply reduced kittiwake production at Chisik Island (Fig. 2). Observing that kittiwake populations have been steadily declining at Chisik while increasing at Gull (Fig. 3), 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 (Fig. 2; J.F. Piatt unpubl. 1997 data), 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

Project 00338

in relation to foraging stress, breeding success, and forage fish abundance. 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).

Current EVOSTC-funded work (APEX, Restoration Project 00163M) measures productivity and foraging differences of seabirds in response to fluctuating prey availability. Preliminary results from research conducted in lower Cook Inlet show some correspondence between 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 is currently being 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 currently being 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 ongoing 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

To test our primary hypothesis- that adult common murre and black-legged kittiwake overwinter survival is related to prey availability and foraging stress during summer- we need to obtain measures of overwinter survival concurrent with measures of prey abundance and distribution. Data on prey (forage fish) abundance and distribution will be obtained via coordinated efforts with EVOSTC-funded projects 00163M (APEX) and 99306 (Sand Lance Ecology). Measures of physiological stress are being obtained in coordination with the EVOSTC-funded project 99479 (Effects of Food Stress on Survival and Reproductive Performance of Seabirds).

We will conduct the proposed research at Chisik and Gull Islands, lower Cook Inlet (Fig. 1). Chisik Island has relatively low prey availability within typical murre/kittiwake foraging ranges, while Gull Island has high prey availability (J. Piatt, unpubl. data). 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 (Fig. 3). Ongoing APEX work has shown a significant relationship between breeding success and foraging effort for kittiwakes, but not for murres (Fig. 2). 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 for kittiwakes (May) and murres (June). 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. The CISeaFFS study is currently 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

Resighting efforts to search for birds banded during FY98 and FY99 will commence in May and June 2000. Initial effort will focus on nest-sites at which birds were banded during previous years. Search coverage will then be expanded to include all visible nests, in order to document any intracolony movement. Coverage will also include roosting rocks and other gathering areas, to look for birds that may skip breeding in the year following banding, but continue to attend the colony. Resignted birds' position in the colony will be noted on archival plot photos or sketches.

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

٩

i.

ł

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..

*Need for additional year of banding fieldwork:* We originally scheduled completion of banding fieldwork in the summer of FY98, and projected FY99 costs based only on resighting during summer 1999 fieldwork. FY00 costs were projected to include only data analysis and writeup. But we were unable to complete our banding objectives during FY98 fieldwork (as detailed in the 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 (Table 1, Table 2).

Furthermore, it has come to our attention that 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 are therefore proposing an additional year of banding during summer 1999, necessitating an additional year of resighting fieldwork during summer 2000. The data analysis and writeup are projected into FY01, instead of FY00 as previously proposed. This extra year would boost our sample sizes into an optimal range, and allow for three years of resighting effort. 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 FY00 and FY01.

#### **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 00

Oct. 1-Jan. 31:	Evaluate results of FY99 work
Feb. 1-April 15:	Arrange resighting logistics
March:	Attend EVOS Symposium
April 15:	Submit Annual Report (FY99 findings)
April 16-June 30:	Conduct field work
Sept. 11-Sept. 30:	Compile resighting results; begin data analysis

# **B.** Project Milestones and Endpoints

Dec. 31, FY 00:	Preliminary data analysis will be completed
April 15, FY 00:	Submit annual report (FY 99 findings)
June 30, FY 00:	Resighting fieldwork will be completed
April 15, FY 01:	Submit annual report (FY 00 findings)
Sept. 30, FY 01:	Preparation of research results for publication in peer-reviewed
	journals will be completed
April 15, FY 02:	Submit final report (FY 01 findings)
-	Manuscripts will be submitted for publication

#### 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 field seasons (FY98, FY99, and FY00) to ensure an adequate sample size and to allow for modification of project design based on initial results. The third field season is necessary due to the aberrant breeding season in 1998, as explained above in Methods. The project will be completed by the end of FY01, which is planned as a close-out year during which no new research will be undertaken. Efforts in FY01 will focus on publication of research results in peer-reviewed journals.

#### **PUBLICATIONS AND REPORTS**

The second planned product of the proposed research will be the annual report detailing FY99 findings, due on April 15, 2000. 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 FY01 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; iii) EVOSTC-funded research on the Pacific sand lance; iv) 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 and, v) ongoing studies of marine fish and oceanography conducted by the University of Alaska, Fairbanks out of the Kasitsna Bay Marine Lab in Kachemak Bay.

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, we did not meet our target goal of banded birds in FY98 owing largely to El Niño effects on bird attendance. Therefore we are asking to extend the project for one year so that we can band adequate numbers of birds for statistical confidence in the survival results.

#### PRINCIPAL INVESTIGATOR

Dr. John F. Piatt Alaska Science Center Biological Resources Division USGS 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-13) 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. David B. Irons, Migratory Bird Management, USFWS. Extensive experience with seabird survival studies in Prince William Sound. Will collaborate on project design, and provide technical guidance.

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 longlived 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 blacklegged 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 blacklegged 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. *In Press.*

- Kitaysky, A.S., J.F. Piatt, J.C. Wingfield, and M. Romano. 1999b. The adreno-cortical stressresponse of Black-legged Kittiwake chicks in relation to dietary restrictions. *In Press* Journal of Comparative Physiology (B).
- 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, 2<sup>nd</sup> 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	<u>n =</u>
 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. Progress of banding work related to EVOS Restoration Project 00338
"Survival of adult murres and kittiwakes in relation to forage fish abundance".
Table shows number of birds banded by year, location, and species.

. .

Year_	Gull I	sland	Chisik Island	
-	Murre	Kittiwake	Murre	Kittiwake
1996	0	9	0	0
1997	30	40	132	69
1998	101	108	56	71
Total	131	157	188	140

·

**,** 



Figure 1. Study area in lower Cook Inlet. Colonies proposed for study of adult survival are located on Chisik and Gull Islands.


Figure 2. Variation in reproductive and behavioral parameters of seabirds at Chisik, Gull, and Barren Island colonies in 1996. Note high and similar breeding success of murres at Gull and Chisik, hypothetically made possible by increased foraging effort of Chisik murres. Chisik kittiwakes were apparently unable to compensate, and therefore failed to produce chicks.



Figure 3. Population trends of murres and kittiwakes showing declines at Chisik Island and increases at Gull Island.

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

		Authorized	Proposed		en and the				
Budget Category	/:	FY 1999	FY 2000					Sec. 1	
Borconnol					가슴! 이 것은 10 옷이 관계했다. 이 것은 이가 이 것이 같아요. 				
Travol									
Contractual			\$ <u>2.7</u> \$8.0						
Commodities			\$2.8						
Equipment			\$0.0	te ma sense se sur la ma de				IENTS	
Subtotal		\$0.0	\$53.2		Londin	Estimated	Estimated		
General Administ	ration		\$6.5			FY 2001	FY 2002		
Project Total		\$0.0	\$59.7			\$46.4	\$0.0	-	
Full-time Equivale	ents (FTE)		1.0						
	. ,			Dollar amoun	ts are shown ir	thousands of	dollars.		
Other Resources						· ·			
Comments:									
				•					
							·		:
<u> </u>									<u> </u>
[	l							ſ	EODM
	-	Project Nun	nber: 0033	8					
FY00		Project Title	: Survival o	of Adult Mur	res and Kittiv	wakes			INUSIEE
1.00			S Geologi	cal Survey					AGENCY
		Agency. U.	o. Geologi	Sai Suivey					SUMMARY

Prepared: 4/13/99

# 2000 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

NamePosition DescriptionStepBudgetedCostsOvertimeFY 2000Thomas Van PeltWildlife BiologistGS-99.03.834.2VacantBiotechGS-52.52.25.50.0<	Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Thomas Van Pelt         Wildlife Biologist         GS-9         9.0         3.8         34.2           Vacant         Biotech         GS-5         2.5         2.2         5.5           0.0         0.0         0.0         0.0           0.0         0.0         0.0         0.0           0.0         0.0         0.0         0.0           0.0         0.0         0.0         0.0           0.0         0.0         0.0         0.0           Subtotal         Subtotal         11.5         6.0         0.0           Description         Ticket         Round         Total         S39.7           Travel Costs:         Description         Price         Tricket         Round         Total         S39.7           Anc/Horn/Anc         0.2         6         0         0.0         1.2           for mark-recapture survival analyses         0.8         1         7         0.1         1.5           for mark-recapture survival analyses         0.8         1         7         0.1         0.0           0.0         0.0         0.0         0.0         0.0         0.0         0.0           0.0         0.0         0.0	Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
Vacant         Biotech         GS-5         2.5         2.2         5.5           Biotech         GS-5         2.5         2.2         0.0         0.0           Use of the second s	Thomas Van Pelt	Wildlife Biologist	GS-9	9.0	3.8		34.2
Subtotal         11.5         6.0         0.0           Subtotal         11.5         6.0         0.0           Subtotal         11.5         6.0         0.0           Costs:         Personnel Total         \$39.7           Travel Costs:         Ticket         Round         Total         Daily           Proposed         Price         Trips         Daily         Proposed           Anc/Horn/Anc         0.2         6         0         0.1         1.2           RIT airfare to attend workshop on statistical techniques         0.8         1         7         0.1         1.5           for mark-recapture survival analyses         0.8         1         7         0.1         1.5           0.0         0.0         0.0         0.0         0.0         0.0         0.0           0.0         0.8         1         7         0.1         1.5         0.0<	Vacant	Biotech	GS-5	2.5	2.2		5.5
Subtotal         11.5         6.0         0.0           Subtotal         11.5         6.0         0.0           Costs:         Personnel Total         \$33.7           Travel Costs:         Ticket         Round         Total         Daily           Proposed         Price         Trips         Days         Per Diem         FY 2000           Anc/Hom/Anc         0.2         6         0         0.0         0.0           for mark-recapture survival analyses         0.8         1         7         0.1         1.5           for mark-recapture survival analyses         0.8         1         0.0         0.0         0.0           0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0           0.0         0.8         1         7         0.1         1.5         0.0						-	0.0
Subtotal         11.5         6.0         0.0           Subtotal         11.5         6.0         0.0           Subtotal         11.5         6.0         0.0           Costs:         Personnel Total         \$39.7           Description         Price         Trips         Days         Per Diary           Anc/Hom/Anc         0.2         6         0         0.0         1.5           for mark-recapture survival analyses         0.8         1         7         0.1         1.5           0.0         0.0         0.0         0.0         0.0         0.0           0.0         0.2         6         0         0.0         1.2           for mark-recapture survival analyses         0.8         1         7         0.1         1.5           0.0         0.0         0.0         0.0         0.0         0.0           0.0         0.0         0.0         0.0         0.0         0.0           0.0         0.0         0.0         0.0         0.0         0.0           0.0         0.0         0.0         0.0         0.0         0.0           0.0         0.0         0.0         0.0         0.0 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>0.0</td>							0.0
Subtotal         Subtotal         11.5         6.0         0.0           Subtotal         11.5         6.0         0.0           Description         Tricket         Round         Total         Parly           Price         Trips         Dass         Per Diem         FY 2000           Anc/Hom/Anc         0.2         6         0         0.0         1.5           for mark-recapture survival analyses         0.8         1         7         0.1         1.5           0.0         0.0         0.0         0.0         0.0         0.0         0.0           Image: Subtotal         Image: Subtotal         Image: Subtotal         Image: Subtotal         Image: Subtotal         Per Diem         FY 2000           RT airfare to attend workshop on statistical techniques         0.8         1         7         0.1         1.5           for mark-recapture survival analyses         0.8         1         7         0.1         0.0           0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0           0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0							0.0
Subtotal     11.5     6.0     0.0       Subtotal     11.5     6.0     0.0       Travel Costs:     Ticket     Round     Total     Daily       Personnel Total     \$39.7       Anc/Horn/Anc     0.2     6     0     0.0       RT airfare to attend workshop on statistical techniques     0.8     1     7     0.1     1.5       for mark-recapture survival analyses     0.8     1     7     0.1     0.0       0.0     0.0     0.0     0.0     0.0       0.0     0.0     0.0     0.0     0.0       0.0     0.0     0.0     0.0     0.0       0.0     0.0     0.0     0.0     0.0       0.0     0.0     0.0     0.0     0.0       0.0     0.0     0.0     0.0     0.0       0.0     0.0     0.0     0.0     0.0       0.0     0.0     0.0     0.0     0.0       0.0     0.0     0.0     0.0     0.0       0.0     0.0     0.0     0.0     0.0       0.0     0.0     0.0     0.0     0.0       0.0     0.0     0.0     0.0     0.0       0.0     0.0     0.0     0.							0.0
Subtotal         11.5         6.0         0.0           Subtotal         11.5         6.0         0.0           Subtotal         11.5         6.0         0.0           Description         Price         Trays         Days         Per Diem         FY 2000           Anc/Hom/Anc         0.2         6         0         0.0         1.5           for mark-recapture survival analyses         0.8         1         7         0.1         1.5           for mark-recapture survival analyses         0.8         1         7         0.1         0.0           0.0         0.0         0.0         0.0         0.0         0.0         0.0           1         7         0.1         1.5         0.0         0.0         0.0           1         7         0.1         1.5         0.0         0.0         0.0           1         0         0.0         0.0         0.0         0.0         0.0           1         0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0         0.0 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>0.0</td>							0.0
Subtotal         Subtotal         11.5         6.0         0.0           Personnel Total         \$39.7           Travel Costs:         Personnel Total         \$39.7           Description         Price         Trips         Days         Per Diern         FY 2000           Anc/Hom/Anc         0.2         6         0         0.0         1.5         6.0         0.0         1.2           Tarate to attend workshop on statistical techniques         0.8         1         7         0.1         1.5         0.0							0.0
Subtotal       11.5       6.0       0.0         Subtotal       11.5       6.0       0.0         Travel Costs:       Personnel Total       \$39.7         Description       Price       Trips       Days       Per Diem       FY 2000         Anc/Hom/Anc       0.2       6       0       0.0       1.2         RT airfare to attend workshop on statistical techniques       0.8       1       7       0.1       1.5         for mark-recapture survival analyses       0.8       1       7       0.1       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0         1       0.1       1.5       0.8       1       7       0.1       1.5         1       0.8       1       7       0.1       1.5       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>0.0</td>							0.0
Subtotal       11.5       6.0       0.0         Subtotal       11.5       6.0       0.0         Travel Costs:       Personnel Total       \$39.7         Description       Price       Trips       Dasy       Per Diem       FY 2000         Anc/Hom/Anc       0.2       6       0       0.0       1.2         for mark-recapture survival analyses       0.8       1       7       0.1       1.5         for mark-recapture survival analyses       0.8       1       7       0.1       1.5         0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.8       1       7       0.1       1.5         for mark-recapture survival analyses       0.8       1       7       0.1       0.0         0.0       0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0       0.0							0.0
Subtoal11.56.00.0Personnel Total\$39.7Travel Costs:Personnel Total\$39.7DescriptionPriceRoundTotalDailyProposedAnc/Hom/Anc0.2600.01.2RT airfare to attend workshop on statistical techniques0.8170.11.5for mark-recapture survival analyses0.8170.00.00.00.00.00.00.00.00.00.00.00.00.00.8170.11.50.00.010.8170.11.50.00.00.00.00.00.8170.11.50.00.00.00.010.10.10.10.10.10.00.00.00.010.10.10.10.10.10.00.00.00.010.10.10.10.10.10.00.00.00.010.10.10.10.10.10.00.00.00.010.10.10.10.10.10.00.00.00.010.10.10.10.10.10.00.00.010.10.10.10.10.10.00.00.010.10.10.10.10.10							. 0.0
Subtotal         11.5         6.0         0.0           Personnel Total         \$39.7           Travel Costs:         Ticket         Round         Total         Daily         Proposed           Description         Price         Trips         Days         Per Diem         FY 2000           Anc/Hom/Anc         0.2         6         0         0.0         1.2           RT airfare to attend workshop on statistical techniques         0.8         1         7         0.1         1.5           for mark-recapture survival analyses         0.8         1         7         0.1         0.0           0.0         0.4         0.4         0.0         0.0         0.0         0.0           0.0         0.4         0.4         0.0         0.							0.0
Personnel Total       \$39.7         Travel Costs:       Ticket       Round       Total       Daily       Proposed         Description       Price       Trips       Days       Per Diem       FY 2000         Anc/Hom/Anc       0.2       6       0       0.0       1.2         RT airfare to attend workshop on statistical techniques       0.8       1       7       0.1       1.5         for mark-recapture survival analyses       0.8       1       7       0.1       0.0         0.0       0.4       0.8       1       7       0.1       0.0         0.0       0.8       1       7       0.1       1.5       0.0         for mark-recapture survival analyses       0.8       1       7       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0 <t< td=""><td></td><td>Subtotal</td><td></td><td>11.5</td><td>6.0</td><td>0.0</td><td></td></t<>		Subtotal		11.5	6.0	0.0	
Travel Costs:TicketRoundTotalDailyProposedDescriptionPriceTripsDaysPer DiemFY 2000Anc/Hom/Anc0.2600.01.2RT airfare to attend workshop on statistical techniques0.8170.11.5for mark-recapture survival analyses0.8170.10.00.00.00.00.00.00.00.010.00.8170.11.5for mark-recapture survival analyses0.8170.10.0 <td< td=""><td></td><td></td><td></td><td></td><td>Per</td><td>sonnel Total</td><td>\$39.7</td></td<>					Per	sonnel Total	\$39.7
Description         Price         Trips         Days         Per Diem         FY 2000           Anc/Hom/Anc         0.2         6         0         0.0         1.2           RT airfare to attend workshop on statistical techniques         0.8         1         7         0.1         1.5           for mark-recapture survival analyses         0.8         1         7         0.0         0.0           0.0         0.9         0.9         0.9         0.0         0.0         0.0           for mark-recapture survival analyses         0.8         1         7         0.1         1.5           for one statistical techniques         0.8         1         7         0.0         0.0           0.0	Travel Costs:		Ticket	Round	Total	Daily	Proposed
Anc/Hom/Anc       0.2       6       0       0.0       1.2         RT airfare to attend workshop on statistical techniques       0.8       1       7       0.1       1.5         for mark-recapture survival analyses       0       0       0.0       0.0       0.0         Image: Constraint of the survival analyses       0       0       0.0       0.0       0.0         Image: Constraint of the survival analyses       0       0       0.0       0.0       0.0         Image: Constraint of the survival analyses       0       0       0.0       0.0       0.0         Image: Constraint of the survival analyses       0       0       0.0       0.0       0.0         Image: Constraint of the survival analyses       0       0       0.0       0.0       0.0         Image: Constraint of the survival analyses       0       0       0       0.0       0.0       0.0         Image: Constraint of the survival analyses       0       0       0       0       0.0       0.0         Image: Constraint of the survival analyses       0       0       0       0       0.0       0.0         Image: Constraint of the survival analyses       0       0       0       0       0       0	Description		Price	Trips	Days	Per Diem	FY 2000
RT airfare to attend workshop on statistical techniques       0.8       1       7       0.1       1.5         for mark-recapture survival analyses       0.8       1       7       0.1       0.0         0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0         0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0	Anc/Hom/Anc		0.2	6	0	0.0	1.2
for mark-recapture survival analyses  for mark-recapture survival analyses  for mark-recapture survival analyses  0.0  0.0  0.0  0.0  0.0  0.0  0.0	RT airfare to attend workshop or	n statistical techniques	0.8	1	7	0.1	1.5
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	for mark-recapture survival	analyses					0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0							0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0							0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0		, ,					0.0
0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0							0.0
0.0 0.0 0.0 0.0 0.0 7ravel Total \$2.7	<i>.</i>						0.0
0.0 0.0 0.0 Travel Total \$2.7							0.0
0.0 0.0 Travel Total \$2.7							0.0
0.0 Travel Total \$2.7							0.0
Travel Total \$2.7		,					0.0
	L					Travel Total	\$2.7
	r						
FORM 3B						F	ORM 3B
Project Number: 00338 Personnel	Project Number: 00338					F	Personnel
<b>FYUU</b> Project Title: Survival of Adult Murres and Kittiwakes	FYUU	Project Title: Survival of Adult Mur	res and Kittiv	wakes		.	& Travel
Agency: U.S. Geological Survey		Agency: U.S. Geological Survey					

Prepared:

# 2000 EXXON VALDEZ TRL E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:	anna an an Anna	1	Proposed
Description			FY 2000
Air charter Homer-Chisik: 6 trips	s @ \$500/trip		3.0
Boat charter (Camp support: Ho	omer-Chisik: 2 trips @ 1500/trip)		3.0
Attendance at workshop on stat	tistical techniques for survival analyses		1.0
Safety training			10
	· · ·		
When a non-trustee organizatio	n is used the form 4A is required	Contractual Total	\$8.0
Commodifies Costs:			Proposed
Description			FY 2000
Fuel and lubricants (resighting f	rom water, 15d per colony @ 10 gal/day @ \$3.00/gal)		1.0
Misc. supplies			1.8
		1	
and the second se			
	· · · · · · · · · · · · · · · · · · ·	Commodities Total	\$2.8
			42.0
			OBM 3B
	Project Number: 00338		
EY00	Project Title: Sunvival of Adult Murree and Kittiwakee		maciual &
	Agonovi, J. S. Goologion Survey	Cor	mmodifies
	Agency. 0.5. Geological Survey		DETAIL
Prepared:			
•			0

3 of 4

#### 2000 EXXON VALDEZ TRU

October 1, 1999 - September 30, 2000

E COUNCIL PROJECT BUDGET

ς.

New Equipment Pure	chases:	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 ass	ociated with replacement equipment should be indicated by placement of an B	New Fau	inment Total	0.0
Existing Equipment	Usage:		Number	Inventory
Description			of Units	Agency
Boston Whaler (camp	and personnel support; @ \$75K)		1	FWS
Laptop computer (data	a management, per island, @ 2 x \$1.5K)		2	USGS
Zodiac inflatables and	motors (resighting from water; camp support, @ 2 x \$ 9K)		2	USGS
Telescopes (resighting	g; @ 2 x \$1K)		2	USGS
Tripods (resighting; @	₽ 2 x \$0.2K)		2	USGS
Binoculars (resighting	; @ 4 x \$0.5K)		4	USGS
1				
L				
			[	7
	Project Number: 00338		F	ORM 3B
	Project Title: Sunival of Adult Murroe and Kittiwakee		E	auipment
1100	Agenery U.S. Coolegies Survey			DETAIL
	Agency: 0.5. Geological Survey			
Prepared:	·			

· ·

·

ר ר

00339 . .

# Prince William Sound Human Use and Wildlife Disturbance Model

Project Number:	00339	
Restoration Category:	General Restoration & Habitat Protection	on
Proposer:	Chugach National Forest	
Lead Trustee Agency:	USFS	
Cooperating Agencies:	ADNR	DECENTED
Alaska SeaLife Center:	No	RECEIVED
Duration:	3rd year	APR 1 5 1999
Cost FY99:	\$ 22.4K	EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
Geographic Area:	Western Prince William Sound	
Injured Resources/Service:	ALL (emphasis on: harbor seal, pigeon trout)	guillemot and cutthroat

# 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. Develop and evaluate a spatial computer 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 FY99 a final GIS (Geographic Information System) representation of existing human use patterns in western PWS was developed. Obtaining information for this database has been a collaborative effort with tremendous support from the Whittier Harbor, Charter 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 00.

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 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 their haulout sites are often approached by tourism and recreational boats. Richardson et al. (1995) provides 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 (Gillikin, D. pers. com.).

# C. Location

This project has focused on western PWS. The project will benefit all State and Federal agencies with management responsibilities in PWS. The project will also benefit other land owners, 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 agreed to cooperate on this project by supplying information on historical

Prepared 04/15/99

and current use patterns, and by commenting on the predicted human use patterns identified by the model. Residents of Chenega Bay and of the nearby AFK Hatchery were asked to participate in 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 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). 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 geographic information system (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

Prepared 04/15/99

Project 00339

work, specific management recommendations were developed for harbor seal (*Phoca vitulina*), pigeon guillemot (*Cepphus columba*), and cutthroat trout (*Oncorhynchus clarki*). 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 (ADNR) 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 FY00

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 2000.

# PUBLICATIONS AND REPORTS

The final manuscripts for this project will be completed in July 2000.

# **PROFESSIONAL CONFERENCES**

The principal investigators will have presented this work and The Wildlife Society national conference in FY99.

#### 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 dispersion model and the model developed through APEX provides important insights into managing seabird populations.

The work reported here would also be integrated into State and Federal agency management and would 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 FY98. The information reported would be incorporated into the Forest planning process. Although the Forest Plan revision effort is anticipated to be completed before these manyscripts would be finalized, the principal investigators would work with the planning team to provide relevant information. The model and recommendations described in the manuscripts would 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, would 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 and FY99 in that preparation of manuscripts for publication in professional journals was not included in thos proposals.

# PROPOSED PRINCIPAL INVESTIGATORS

Karen A. Murphy Chugach National Forest Glacier Ranger District P.O. Box 129 Girdwood, AK 99587 (907) 783-3242 Lowell H. Suring Chugach National Forest 3301 C Street Ste 300 Anchorage, AK 99503 (907) 271-2836 (907) 271-3992 (FAX)

## PRINCIPAL INVESTIGATORS

#### 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 coauthored 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. Lowell will have primary responsibility in development of the human use dispersion model.

# Karen A. Murphy

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

# **OTHER KEY PERSONNEL**

Ali Iliff, Natural Resources Manager who works for ADNR represents the Division of Lands and the Division of State Parks and Outdoor Recreation on this project.

#### 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.

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

.

· · · · · · · · · · · · · · · · · · ·	Authorized	Proposed						
Budget Category:	FY 1999	FY 2000					1	
						(1996) Stra		
Personnel		\$17.6			al an isan tana			
Travel		\$0.0						
Contractual		\$0.0						
Commodities		\$2.2			그는 모험			
Equipment	-	\$0.0	i	LONG RA	ANGE FUNDIN	IG REQUIREN	MENTS	
Subtotal	\$0.0	\$19.8			Estimated	Estimated		
General Administration		\$2.6			FY 2001	FY 2002		
Project Total	\$0.0	\$22.4						
-		-	S. S. Santa					Line Line -
Full-time Equivalents (FTE)		0.3			966-0-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1		- 10 A	
			Dollar amoun	ts are shown ir	n thousands of	dollars.		
Other Resources				1				1
					-			
FY00 Prepared:4/14/99, KEH	Project Num Project Title Agency: U.	nber: 00339 9: Human U S. Forest S	9 se Model Service				F T S	FORM 3A TRUSTEE AGENCY SUMMARY

#### 2000 EXXON VALDEZ TRU: COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
L. Suring	Wildlife Biologist	GS-12	1.5	6.4		9.6
K. Murphy	Wildlife Biologist	GS-11	1.5	5.3		8.0
	- ·					0.0
	· ·					0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal				0.0	0.0
	Sublota		3.0	<u>    . /</u>	sonnel Total	\$17.6
Traval Costs:	· · · · · · · · · · · · · · · · · · ·	Ticket	Round	Total	Daily	Proposed
Description		Price	Trins	Davs	Per Diem	FY 2000
	<u></u>		Inpo			0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
·						Q.0
						0.0
				•		0.0
	· · · ·					0.0
		······			Travel Total	\$0.0
	Project Number: 00220				F	ORM 3B
EVOO					P	ersonnel
	Project Litle: Human Use Model					& Travel
	Agency: U. S. Forest Service					
<b>_</b> ]					L	

.

ŗ

#### 2000 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:		Proposed
Description		FY 2000
When a non-trustee organization is used, the form 4A is requir	red. Contractual Total	\$0.0
Commodities Costs:		Proposed
Description		FY 2000
Manuscript publication (two)		2.0
misc.		0.2
	Commodities Total	\$2.2
FY00 Project Number: 00339 Project Title: Human Us Agency: U. S. Forest So	se Model ervice	DRM 3B tractual & nmodities DETAIL

#### 2000 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

.

October 1, 1999 - September 30, 2000

1

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	Now Equ	inment Total	0.0
Existing Equipment Usage:		Number	loventon/
Description		of Units	Agency
	<u> </u>		, geney
			1
	· · · · · · · · · · · · · · · · · · ·		
Project Number: 00339		F	ORM 3B
FYNN Draiget Title: Human Llag Madel		E E	uipment
		1	
Agency: U. S. Forest Service		'	

.