A monitoring program for near-surface temperature, salinity, and fluorescence fields in the Northeast Pacific Ocean

(Collaborating institutions: Institute of Marine Science, University of Alaska Fairbanks (lead institution) and Center for Coastal Physical Oceanography, Old Dominion University)

Project Number:	03614
Restoration Category:	Ecosystem Synthesis/GEM Transition/New Projects/ Innovative Tools and Strategies to Improve Monitoring
Proposer:	Stephen R. Okkonen Institute of Marine Science University of Alaska Fairbanks Fairbanks, Alaska 99775
Lead Trustee Agency:	ADF&G
Alaska Sea Life Center:	No
Duration:	2nd year, 2-year project
Cost FY 03:	$18,100
Geographic Area:	Northeast Pacific Ocean
Injured Resource/Service:	

ABSTRACT

The objective for this proposed research is to a use a thermosalinograph and fluorometer, to be installed on a crude oil tanker, to acquire continuous, long-term measurements of the near-surface temperature, salinity, and fluorescence fields along the tanker route between Valdez, Alaska and Long Beach, California.

INTRODUCTION

The research proposed herein describes a two-year, proof-of-concept project to demonstrate the use of a crude oil tanker as a platform from which to acquire measurements of oceanographic field variables (near-surface temperature, salinity, and fluorescence) in the Northeast Pacific Ocean. The results from this project will be used as a basis to pursue GEM funding for long-term monitoring of oceanographic field variables from crude oil tankers.

NEED FOR THE PROJECT

A. Statement of Problem

In order to assess the long-term recovery of marine resources impacted by the Exxon Valdez Oil Spill against the background of climate-driven variability of those resources, long-term measurements of oceanographic conditions are required. Additionally, while the most significant spill-related impacts upon the marine environment occurred in coastal and near-shore domains, the long-term health of those marine ecosystems depends, in part, upon biophysical linkages to the shelf, slope, and open-ocean domains. Consequently, multi-decadal records of oceanic conditions within each of these domains is necessary to develop an understanding of natural and anthropogenic variability in the marine environment of the northern Gulf of Alaska.

B. Rationale

In recent years there has been increasing awareness of large-scale, multi-decadal changes in the climate of the world ocean. However, translating awareness of long-term climate variability into understanding the regional and local physical and biological consequences of a changing environment has been hampered by the dearth of long-term oceanographic measurements in the Northeast Pacific. Presently, the only multi-decadal time series of oceanographic conditions (temperature and salinity) in the region are for Ocean Station P/Line P and station GAK-1 near Seward, Alaska (Figure 1).

Commercial cargo vessels operating within established shipping corridors in the Northeast Pacific are potential ships-of-opportunity from which high-resolution measurements of oceanographic conditions could be acquired at regular intervals. Crude oil tankers, traveling between Valdez, Alaska and Long Beach, California are particularly well suited for this purpose as individual tankers cross shelf, slope, and open ocean regimes every ten to fourteen days and will continue to do so for many years to come.

To demonstrate the suitability of tankers as a traveling platform, we propose to install a thermosalinograph (TSG) and fluorometer on a tanker to acquire high-resolution measurements of near-surface temperature, salinity, and fluorescence (a proxy for phytoplankton biomass).

Some might argue that satellites are better platforms from which to acquire these measurements of ocean surface conditions. However, ocean color and sea surface temperature sensors detect wavelengths in the visible and infrared portion of the electromagnetic spectrum and are therefore unable to detect sea surface features through the clouds, which cover much of the Gulf of Alaska for much of the year. With respect to remote sensing of sea surface salinity, there are no satellite-borne salinity sensors at this time.

C. Location

Measurements of temperature, salinity, and fluorescence will be acquired along the tanker corridor between Valdez, Alaska and Long Beach, California (Figure 1).

PROJECT DESIGN

A. Objectives

The objectives for this project are to:

1. Establish a working relationship with the crude oil tanker fleet to use individual tankers as platforms from which to acquire continuous, long-term measurements of oceanographic field variables (e.g. temperature, salinity, fluorescence) along the shipping corridor between Valdez, Alaska and Long Beach, California. Install a thermosalinograph and fluorometer on a tanker to acquire these measurements.

2. Identify the seasonal migration and evolution of frontal features associated with the Alaska Coastal Current (ACC), shelf break, and mesoscale eddies.

3. Identify the dominant length scales of variability (and seasonal modulation of those length scales) characterizing the near-surface temperature, salinity, and fluorescence fields along the shipping corridor. These scales of variability will likely differ between the shelf and the open ocean.

4. Compare TSG/fluorometer measurements with TOPEX altimeter observations of the Gulf of Alaska eddy field.

5. Compare TSG/fluorometer data with contemporaneous NEP GLOBEC field data.

6. Provide temperature, salinity, and fluorescence field data to David Welch (Pacific Biological Station, Nanaimo, British Columbia) for comparison with coincident continuous plankton recorder (CPR) observations.

A. Methods

The TSG and fluorometer will be installed in the sea chest of a tanker. The sea chest draws seawater through an intake located a few meters below the sea surface. The exact depth of the intake water will depend on the particular vessel design and the amount of cargo and/or ballast carried. With approval of the ship's chief engineer, a remote temperature sensor will be installed as close to the intake as is practical to mitigate biasing of the temperature measurements due to the ship's thermal inertia.

TSG and fluorometer measurements will be acquired once per five seconds (nominal). For a tanker traveling at twenty knots this translates to a sample spacing of ~50 m. This data stream will be merged with concurrent GPS navigation data and stored on the hard drive of a dedicated personal computer. Repeat measurements along the shipping corridor will allow time-space matrices of temperature, salinity, and fluorescence to be constructed. After a yearlong record of measurements is acquired, characteristic spatial scales of variability and their seasonal modulation will be determined from spectral and geometric analyses of the data matrices.

The seasonal evolution of frontal features associated with the ACC, the shelf break, and mesoscale eddies will also be monitored. Because of secondary circulation associated with frontal features, they tend also to be zones in which there are population aggregations across many trophic levels.

SCHEDULE

A. Measurable Project Tasks for FY 02 (1 October 2001 – 30 September 2002)

15 Oct 01:	Order instrumentation and ancillary hardware
15 Feb 02:	TSG arrived in San Diego
Apr 02:	Dave Cutchin visits Polar Alaska to meet with captain and chief engineer and look over engine room plumbing
May 02:	Install TSG
May 02 – 30 Sep 02:	Data acquisition

B. Project Milestones and Endpoints

Oct 2001 – ongoing	Project Design Objective 1
May 2002 – ongoing	Project Design Objectives 2, 4, 5, 6
1 Jan 2003 – 1 Mar 2003	Project Design Objective 3 (use first year of data)
1 Mar 2003 – 30 Apr 2003	Prepare manuscript(s), see Publications and Reports section below
15 Apr 2003	Submit annual report

C. Completion Date

30 Sep 2003	Completion of final report

PUBLICATIONS AND REPORTS

No publications are anticipated for FY 02.

Potential FY 03 publications: Seasonal evolution of frontal features in northern Gulf of Alaska; Comparison of TSG, fluorescence, and TOPEX altimeter observations of Gulf of Alaska eddies; Comparison of TSG, fluorescence and continuous plankton recorder observations in the Northeast Pacific Ocean (with David Welch, Pacific Biological Station, Nanaimo, British Columbia).

PROFESSIONAL CONFERENCES

Attend Trustee Council's annual workshops in Anchorage in January 2002 and 2003.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Data acquired for this project will be posted on the UAF/Institute of Marine Science web page.

Okkonen has an ongoing NASA-funded project to use the TOPEX altimeter to observe the mesoscale eddy field in the Gulf of Alaska and to share that data with collaborating NEP GLOBEC researchers (Tom Weingartner, University of Alaska Fairbanks; Tom Royer, Old Dominion University)

Royer is a funded researcher with the NEP GLOBEC project for the next four years.

Existing collaborative relationships with NEP GLOBEC researchers will be exploited to (1) compare TSG surface field observations (this proposed research) with contemporaneous subsurface temperature and salinity measurements from within Prince William Sound and from the nearby shelf and (2) use retrospective studies of historical VOS (XBT and XCTD) and GAK1 data to provide a historical context for consideration of the TSG data.

The opportunity also exists to make similar comparisons of the TSG data with historical and contemporaneous Ocean Station P/Line P data.

We also plan to share our data with David Welch, Pacific Biological Station, Nanaimo, British Columbia. He has a current project in which he has a continuous plankton recorder (CPR) deployed five times per year on a tanker traveling between Valdez and Long Beach. The TSG/fluorometer/CPR data sets would be highly complementary in that temperature, salinity, and fluorescence gradients could be directly compared with plankton distributions along the tanker route.

PROPOSED PRINCIPAL INVESTIGATOR

Stephen R. Okkonen
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Okkonen will have primary responsibility for initial data processing, length scale analyses, frontal feature analyses, and comparison with TOPEX data.

CO-PRINCIPAL INVESTIGATOR

Thomas C. Royer
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Department of Ocean, Earth, and Atmospheric Sciences
Old Dominion University
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(757) 683-5550 (FAX)
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Royer will have primary responsibility for comparison of TSG data with GLOBEC data and with historical data.

OTHER KEY PERSONNEL

Dave Cutchin
San Diego, California

Dave Cutchin will be issued a sub-contract to install the thermosalinograph, fluorometer, and ancillary hardware on the tanker and to provide annual maintenance of the instruments. He was responsible for TSG installations on other VOS platforms both prior to and during WOCE.

Dave Cuthcin will install a thermosalinograph (TSG)on the Polar Alaska or other suitable oil tanker. This includes plumbing the TSG into a seawater supply, connecting the TSG to ships' power, running a cable up to the bridge or other location suitable for a computer/recorder, installing the computer/recorder, connecting to a GPS antenna and testing the system. This does not include any hardware, plumbing or electrical supplies, the calibration of the TSG, its routine operation or the removal/processing of

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Budget Category:	Authorized FY 02	Proposed FY 03						
Personnel		$8.6						
Travel		$0.7						
Contractual		$3.6						
Commodities		$0.4						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$13.3	Estimated					
Indirect		$3.3	FY 04					
Project Total	$0.0	$16.6						
Full-time Equivalents (FTE)		0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

NOTE: ADF&G GA of 9% ($1.5) needs to be added to this project, bringing project total to $18.1.

FY03

Prepared:

Project Number: 030614
Project Title: Collaborative Proposal: A monitoring program for near-surface temperature, salinity, and fluorescence fields in the Northeast Pacific Ocean
Name: University of Alaska Fairbanks

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Personnel Costs:			Months	Monthly		
	Name	Position Description	Budgeted	Costs	Overtime	
	Okkonen, S.	PI, Research Asst. Professor	1.5	4.8		
	Partee, D.	Web Page Developer	0.3	4.8		
		Subtotal	1.8	9.6	0.0	
					Personnel Total	

Travel Costs:		Ticket	Round	Total	Daily	
	Description	Price	Trips	Days	Per Diem	
	Kenai - Anchorage (Trustee Council workshop)	0.2	1	0	0.0	
	per diem			2	0.2	
	Taxi	0.1	1			
					Travel Total	

FY03

Prepared:

Project Number: 03614
Project Title: Collaborative Proposal: A monitoring program for near-surface temperature, salinity, and fluorescence fields in the Northeast Pacific Ocean
Name: University of Alaska Fairbanks

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

Contractual Costs:	
Description	
Dave Cutchins (subcontract for annual instrument maint.) TSG calibration Kill cell Annual fluorometer characterization RT shipping Publications Software maintenance Phone, fax, internet, postage	
Contractual Total	
Commodities Costs:	
Description	
Project supplies/postage	
Commodities Total	

FY03

Prepared:

Project Number: 03614
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FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

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

Existing Equipment Usage:	Number of Units	
Description		

FY03

Prepared:

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