EVOS PROPOSAL SUMMARY PAGE

(Trustee Council Use Only)
Project No. ***G-030685***
Date Received ***9/4/02; TC approved 11/25/02***

Project Title: Visible remote sensing of the Gulf of Alaska

Project Period: FY 03

Proposer: W. Scott Pegau
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EVOS Funding: $77,100

Matching Funds: none

Study Location: Gulf of Alaska, Kachemak Bay

Trustee Agency: ADFG

Abstract:
A number of visible remote sensing satellites have been observing the Gulf of Alaska and its watersheds for the past five years and will continue to make observations into the future. Much of the data is available through NASA; however, the data is not easily accessible, fully quality controlled, or necessarily the variables of interest. This synthesis proposal aims to 1) determine which products would be useful to resource managers and scientists, 2) develop a system to process and provide the existing and future satellite data in a format useful to most users, and 3) provide quality control. The satellite imagery covers all zones described in the GEM Program Document, but this proposal focuses on the oceanic components. The work is a collaborative effort led by the Kachemak Bay Research Reserve with the University of Alaska-Fairbanks providing processing facilities.

I. INTRODUCTION

This proposal is a synthesis proposal designed to collect the available visible remote sensing data and provide useful products in an easily accessible manner. There are three major aspects to the proposed work. First is to determine what products are likely to be useful to fisheries and other resource managers, the scientific community, and coastal communities. We will then process the existing data and set up routines to automatically process future data and make it available in convenient formats to view or incorporate into GIS. Such formats include JPEG thumbnails and geo-referenced TIFF. Lastly we will provide an indication of image quality. One simple measure of quality is the scan angle. At high scan angles the spatial resolution is poor providing a blocky appearance to the image. An example of this problem is provided in figure 1.

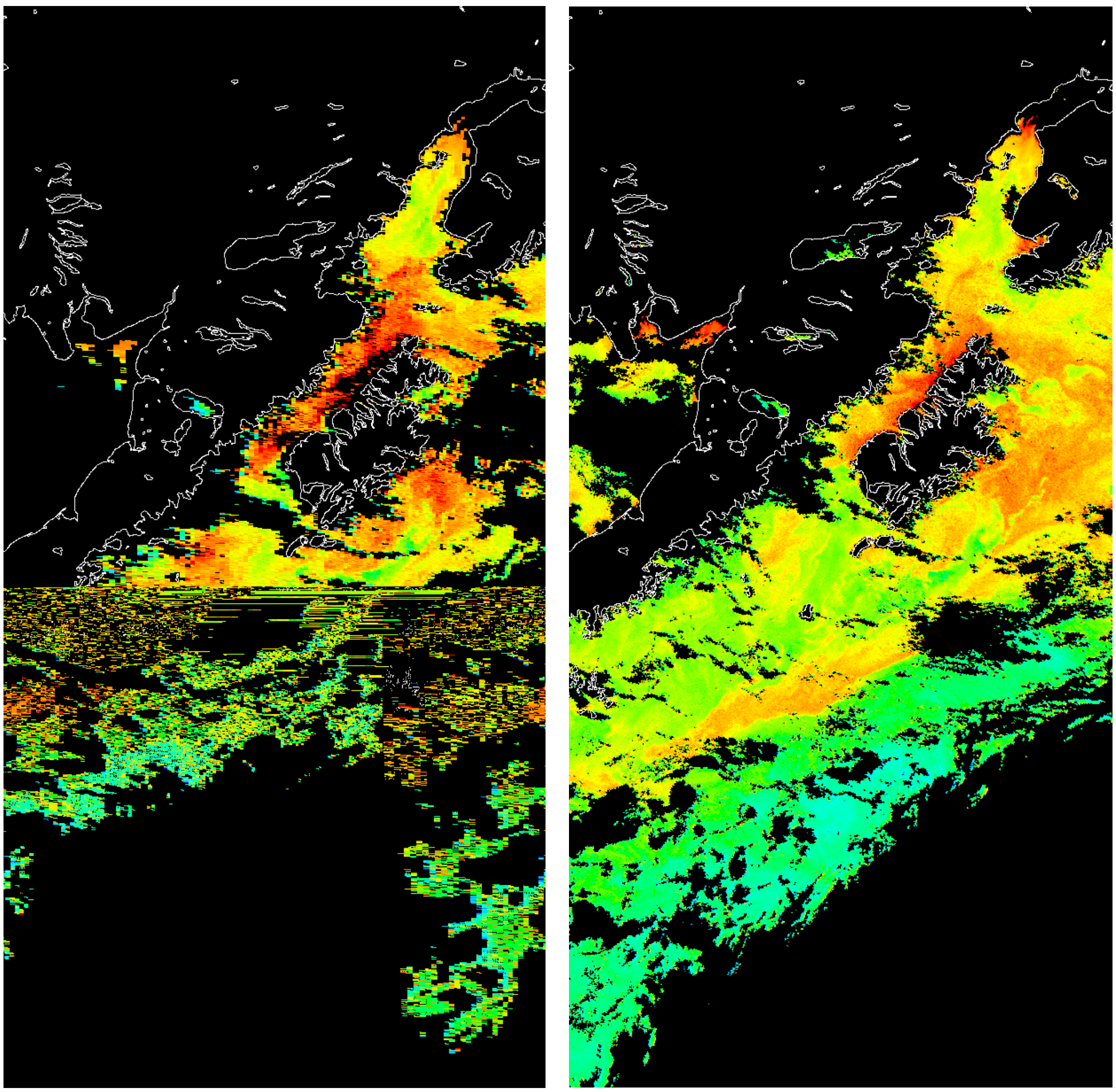

Figure 1. Two SeaWiFS chlorophyll images from August 28, 2001 taken at 2100 and 2300 GMT respectively. Note the blocky appearance caused by high scan angle on the left side of the 2100 image.

Color remote sensing data is currently used to derive many products in the ocean, land, and cryosphere systems (the Navy produces approximately 60 products for SeaWiFS imagery), however many of these products are not needed by a wide range of researchers or resource managers, and other possibly more useful products that could be produced are not available. Products currently produced that are called for in the GEM Program Document include ocean chlorophyll concentration and NDVI. Other products that have been demonstrated include, frontal position, surface currents, sediment loading, bloom timing and extent. Differences between satellites in the variables produced, data format, data quality, and availability makes developing a useful time series difficult. Add to that the processing time required (about 1 month of Sun workstation time per year of SeaWiFS data) and it becomes readily apparent that there is a need to make a time series that contains the appropriate products, and that is much more accessible to a variety of users.

Currently there are 10 color sensors with high enough signal to noise characteristics to be of use in both terrestrial and marine systems. An additional 3 sensors have flown in the past, with full coverage of the Gulf beginning in 1996 with the OCTS satellite. Several more sensors are planned for the future with ocean color being transitioned to an operational resource, like SST, allowing color measurements to provide a long time series of oceanographic and terrestrial data. A high-quality time series will only be possible by a careful melding of the different data sources.

II. NEED FOR THE PROJECT

A. Statement of Problem

The Gulf of Alaska is a vast region with high spatial and temporal variability in productivity and hydrodynamic structure. ***The problem is how to economically monitor the Gulf of Alaska from the Subarctic Gyre to the coastal region in order to assess changes in productivity.*** Remote sensing provides a tool that can be used to rapidly observe changes in the surface waters of the entire region. Ocean color is directly related to chlorophyll-a concentration and changes in concentration measure the net primary productivity. Over short time scales the phytoplankton can be considered a passive tracer, and therefore the change in chlorophyll distribution an indication of the fluid flow (Pegau et al., 2002). Over longer time scales we can observe seasonal and annual variability within the region. Combining the OCTS, SeaWiFS, and MODIS sensors provides a data set of nearly continuous coverage from the fall of 1996 to present.

Several other types of satellites provide remote sensing products that are important for understanding the oceanic conditions in the Gulf of Alaska. During the workshop we will discuss the variables that those satellites produce (SST, winds, sea surface height) and which are desirable. Because of the budget and time constraints we are not proposing to develop processing routines for those satellites. The choice to start with visible remote sensing is based on the principal investigators background and the wide array of products available from color imagery.

One problem that this proposal addresses is how to make the remote sensing data more accessible. The University of Alaska has been downloading SeaWiFS data for the past five years; however, they only archive the raw data and do not keep the processed images. Thus every investigator that wishes to use the ocean color data must reprocess it for themselves. With a moderately fast workstation it takes approximately one month to process each year of data. By not having a central data facility several man months each year are spent processing images that someone else may have processed. The SeaWiFS project office maintains remapped images of some products. These images are averaged in time and space and do not necessarily consider all of the quality control factors important to the local region. The spatial and temporal averaging tends to smear out eddies and jets that are important markers of the fluid flow and regions where fish tend to congregate. The spatial averaging also causes the loss of data in the nearshore region because of the complex fjord nature of the coastline along the Gulf of Alaska. To clearly observe the ACC and its terrestrial inputs requires maintaining a database of full spatial and temporal resolution images.

The last problem that this proposal addresses is the quality of the remote sensing data. Several sources of error exist in the chlorophyll-a concentration product. Approximately 90% of the signal measured at the satellite derives from scattering within the atmosphere. This signal must be corrected for before the water leaving radiance and chlorophyll can be determined. This atmospheric correction is a major source of error in the water leaving radiance, especially at low solar elevations that are characteristic of high latitudes. How bad this problem is depends on the satellite geometry and overpass time, which vary between the three satellites to be considered in this study. The algorithms are also affected by changes in colored dissolved organic materials and suspended sediments, both are common within the riverine inputs that become the ACC. The quality of optics and in-flight calibrations also vary between sensors. To understand changes in productivity we will need to understand the accuracy of the sensors. This proposal contains a minimal satellite validation component and funds will be sought from NASA to provide a more comprehensive validation program for the region.

B. Rationale/Link to Restoration

In establishing the GEM Program, the Trustee Council explicitly recognized that complete recovery from the oil spill may not occur for decades and that full restoration of injured resources will most likely be achieved through long-term observation and, as needed, restoration actions. The Council further recognized that conservation and improved management of injured resources and services will require substantial ongoing investment to improve understanding of the marine and coastal ecosystems that support the resources, as well as the people, of the spill region. In addition, prudent use of the natural resources of the spill area without compromising their health and recovery requires increased knowledge of critical ecological information about the northern Gulf of Alaska. This knowledge can only be provided through a long-term monitoring and research program that will span decades, if not centuries.

C. Link to GEM Program Document

Because the Gulf of Alaska covers a vast area the only mechanism for rapidly sampling the entire region is satellite remote sensing. Remote sensing also crosses habitat regions allowing the interactions between the Alaska Coastal Current (ACC), Alaska Current (AC), and Subarctic Gyre (SG) to be observed at the same time. When combined with terrestrial remote sensing it is possible to observe the impact of land use changes on the local oceanic productivity. One product from the remote sensing that will be made available is chlorophyll a concentration. This is identified as part of the specific information needed to address the question of what is the annual variability in primary productivity in the ACC and Gulf of Alaska. By developing a time series of imagery it will be possible to determine how productivity changes with time or in the presence of small-scale anthropogenic influences.

The pattern of phytoplankton or sediment concentration can also be used to measure the annual variability of location and dynamics of the ACC, another question put forth in the GEM Program Document. With three remote sensing platforms passing the region two hours apart and nearly daily coverage by the three satellites it is possible to track the position and flow off the ACC by how features in phytoplankton concentration are advected in the time between images.

III. PROJECT DESIGN

A. Objectives

The objectives of the proposed work include:

1. Determine the products and format of visible remote sensing that are most likely to be required by scientists and resource managers.

2. Develop a set of quality control measures to be added to each data set.

3. Develop a time series of the appropriate variables by developing the appropriate tools to process the remote sensing data in accordance with the needs identified within objective 1.

B. Procedural Methods

To achieve the first objective we are planning a workshop in Homer that will collect people from around the Gulf that may potentially utilize the data. The makeup of the workshop will include fisheries managers from ADF&G and NOAA/NMFS, oceanographers, commercial fisheries and community interest groups. The workshop will begin with the capabilities and restrictions of the remote sensing data, followed by a discussion of the present products and potentially useful products. The workshop then will be turned to a discussion of which products are most likely to be needed to achieve the goals of GEM and the needs of scientists and resource managers in the region. Once the appropriate products are identified we will determine the most useful data formats. Other issues to be discussed are the level of spatial and temporal averaging that may be allowed for the various products, and what are data quality concerns. In addition to the meeting in Homer we will query participants at the annual EVOS workshop on their desires for products and data format.

Quality control measures will be developed by combining a review of a subset of existing imagery with a small validation program. The first step will be to review images for obvious sources of error or quality degradation. Many of these sources have been previously identified (e.g. scan angle, cloud cover, proximity to land), a few more are likely to be regionally related problems (e.g. low sun elevation and high sediment loads). The next step will be to compare imagery collected on the three platforms (SeaWiFS, MODIS terra and aqua) to determine differences in image quality and values of the desired parameters. Errors in atmospheric correction due to satellite geometry and spectral characteristics are very important sources of error at high latitudes and such errors will become evident in an intercomparison. For an example of this problem please refer to Figure 1 and note how much more dark red (high chlorophyll) the 2100 image has compared to the 2300 image. The change in phytoplankton concentration is not physically realistic and is related to the larger scan angle causing errors in the atmospheric correction that translate into the chlorophyll estimate. The MODIS terra has a number of known instrumental defects that may make the data quality poorer than from another platform such as MODIS aqua. It is likely that we can restrict the overpass characteristics enough to reduce the number of images needing to be processed by a factor of two.

The comparison is to quantify the variability between sensors and when possible identify the likely source of variability. Because the comparison can only identify differences, and not which sensor is most accurate, we are proposing a very small validation campaign. We will on 12 occasions in the spring and early summer collect reflectance data at a point in outer Kachemak Bay using a Satlantic Hyperspectral TSRB and surface chlorophyll concentrations using standard fluorometric techniques. The TSRB measures downwelling irradiance and upwelling radiance every 3 nm between 400 and 750 nm. The sensor will be calibrated at the manufacturer's facility during the winter to ensure calibration error of <5%. The chlorophyll-a concentration will be determined from water samples collected at or near the surface. The samples will be filtered through a GFF glass fiber filter, extracted in acetone, and a Turner fluorometer used to determine chlorophyll concentration. The location of the samples will be determined by GPS and maintained in the meta data file. We will follow the NASA ocean color protocols for both reflectance and chlorophyll measurements to ensure the methods conform to national standards. It is important to implement this ground-truthing campaign because the work being done by NASA focuses on lower latitudes and oligotrophic waters where many of the expected sources of error are smaller.

To achieve our third objective we will order all of the available ocean color data. For SeaWiFS we will obtain the archived level 1 data from the UAF HRTP station, which has the best coverage of the region. For those products that have existing processing algorithms we will set up and begin to run the processing macros to provide mapped data. We will determine how to implement algorithms for products not available from SeaDAS. The data from the two MODIS systems come in a format different than the SeaWiFS data. The SeaDAS processing routine can also handle data from MODIS, but other routines exist that may be more appropriate (e.g. those from the OSU remote sensing group). A reason other software may be more appropriate is because the MODIS data comes in small "granules" that will need to be pasted together to fill the area of interest. Products not available from the MODIS program will use the same algorithms used for the SeaWiFS data.

C. Statistical Methods

The Gulf of Alaska is viewed by each of the three color satellites approximately twice each day. SeaWiFS coverage does not include the time from mid-November to early February because of low light levels. The MODIS sensors have a slightly longer gap because of their overpass times are not near solar noon. Over five years of data have been collected and just need to be made accessible.

We expect that between 3 and 10 times each year conditions will allow enough consecutive images that surface currents can be derived. Chlorophyll-a for the entire region is generally available each 10 days. The range of detectable chlorophyll levels being nearly three orders of magnitude. The imagery is sufficient for detecting changes in the seasonal and annual patterns of chlorophyll standing stocks.

D. Description of Study Area

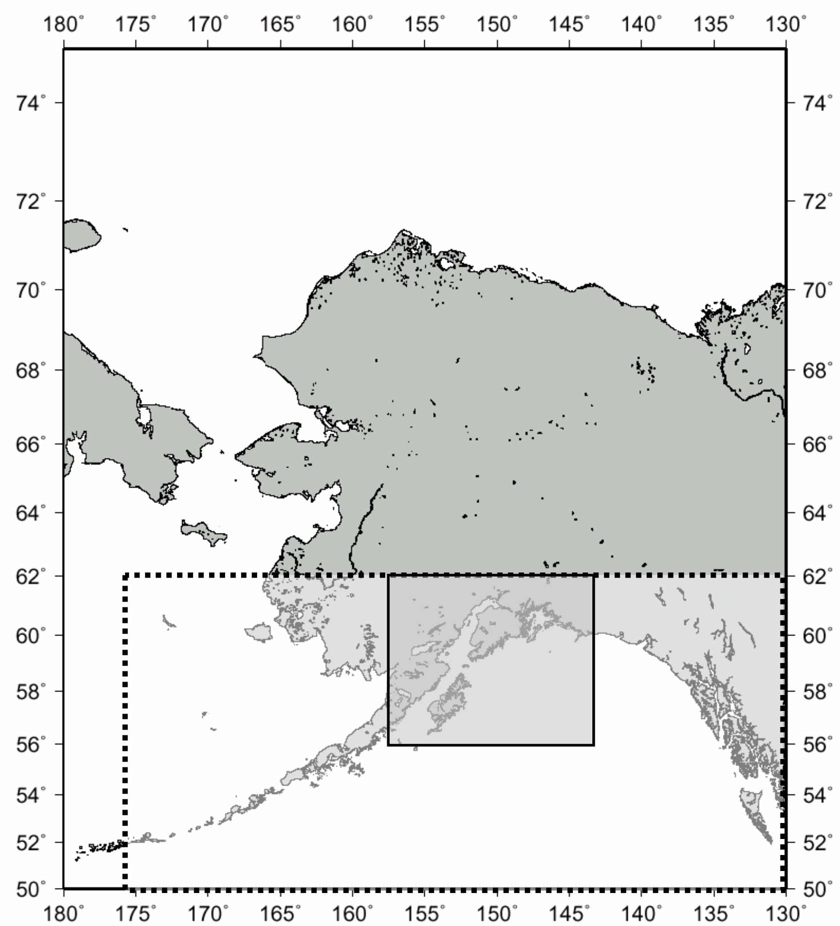

Figure 2. Data within the dashed box will be processed to 5 km resolution. Data within the gray box will be processed to full 1 km resolution in order to provide the highest detail of small current structures associated with the ACC and allow the data to extend as close as possible to the complex coastline.

The regions of interest are indicated in Figure 2. There are two levels of interest. The first is a large box between 50 to 62°N and 130 to 175°W. In that region the data will be processed to a 5 km resolution that is sufficient to identify the broad features extending from the coast to the Subarctic Gyre. In the box bounded by 56 to 62°N and 143 and 158°W the data will be processed to 1 km resolution in order to retain data near the complex coastline and to fully resolve smaller spatial features like the ACC. The satellite validation groundwork will take place within Kachemak Bay at 59.583, -151.666.

E. Coordination and Collaboration with Other Efforts

Not enough detail is available to fully assess the relevance of the work recommended for funding under phase I and the work proposed here. I believe that there will be connections between this project and project 02584 in determining applications to remote sensing data, although the work here uses lower spatial and higher temporal resolution than can be expected from an airborne system. Projects 02340 and 02642 are potential sources of additional product validation data. In turn this project will set the spatial context for those measurement programs. We will coordinate our work and products with that proposed by Evelyn Brown titled, "Remote sensing for GEM watersheds and the nearshore region". We will also work to ensure our data is compatible with the proposal by Dale Kiefer titled, "An information system for Kachemak Bay Research Reserve: A model for GEM's information system?"

This work would be of some interest to NASA remote sensing validation programs, such as SIMBIOS. While working at Oregon State University I received funding for satellite validation work from NASA and I processed and remapped SeaWiFS chlorophyll imagery for the Coastal Western U. S. (photon.oce.orst.edu/ocean/projects/seawifs/seawifs.html). I am not currently funded to do satellite validation or maintain the SeaWiFS imagery.

IV. SCHEDULE

A. Project Milestones

Objective 1. Develop a list of appropriate products and data formats.
To be met by April 2003.

Objective 2. Develop a list of quality control flags.
To be met by May 2003.

Objective 3. Develop and test the required processing algorithms.
To be met by September 2003. Some products may require major algorithm development and those routines will not be in place during this proposed effort.

B. Measurable Project Tasks

FY 03, 1st quarter (October 1, 2002-December 31, 2002)	
November 25:	Project funding approved by Trustee Council

FY 03, 2nd quarter (January 1, 2003-March 31, 2003)	
January 13-17:	Annual EVOS Workshop (joint symposium with GLOBEC and NMFS)
March 14	Hold workshop to determine appropriate products and data formats
March	Begin satellite validation sampling

FY 03, 3rd quarter (April 1, 2003-June 30, 2003)	
May 31:	Complete quality control flag analysis Begin developing automated processing algorithms utilizing quality control flags.
June 30:	Complete satellite validation sampling and processing of samples

FY 03, 4th quarter (July 1, 2003-September 30, 2003)	
September 15:	Complete testing of automated processing algorithms
September 30:	Submit final report to EVOS

V. RESPONSIVENESS TO KEY TRUSTEE COUNCIL STRATEGIES

A. Community Involvement and Traditional Ecological Knowledge (TEK)

We will seek involvement of the local and fishing communities during the workshop to determine appropriate products. We will incorporate the capabilities of the educational staff at KBRR to develop an outreach effort based on the workshop. They will also be asked to provide a conceptual design of an outreach program for the satellite data that will be processed.

B. Resource Management Applications

The first objective of this proposal is to work with resource managers to inform them of the potential for using the ocean color measurements in making decisions, and more importantly determine what products are most likely to be of use to the managers. Based on discussions with local ADF&G fisheries biologists two products most likely to be of use to managers are surface circulation patterns and timing of phytoplankton blooms. Surface currents will help managers understand the likely trajectories of contaminants, flotsam, and larval organisms. By determining the timing of the phytoplankton blooms in fisheries nursery grounds we will be able to determine the likely prey abundance for the juvenile fish. The blooms are also likely to be useful for predicting herring weight at time of spawning, which affects the likely time of spawning and spawning success. For instance, the existence of a fall bloom in productivity would allow the fish to put on and carry more weight through the winter causing the herring to spawn earlier in the season. During the time period from 1998 to 2002 two patterns of phytoplankton blooms have occurred in the Gulf of Alaska (Figure 3). One pattern has a phytoplankton bloom in late June or early July, the second has peaks in phytoplankton standing stocks in April and September with a minimum during June and July. By understanding the relationships between the juvenile fish and the primary production we can estimate juvenile survival and hence likely year class strengths or salmon returns.

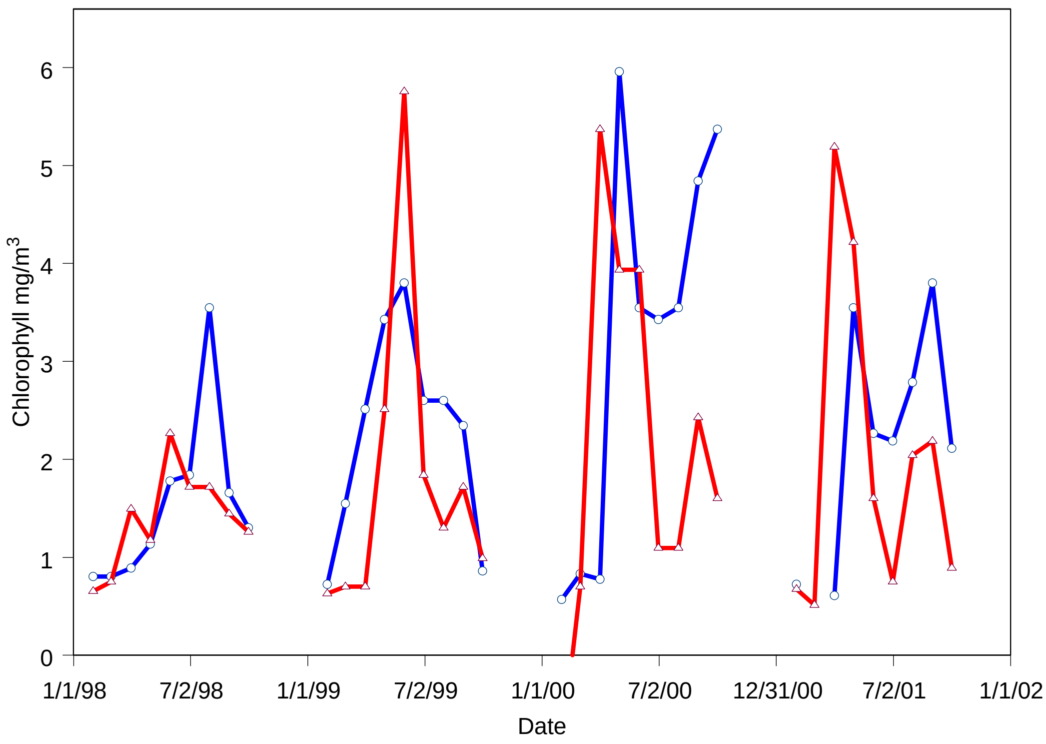

Figure 3. Monthly averaged chlorophyll concentrations at two locations in the Northern Gulf of Alaska are presented. In 1998 and 1999 the spring peak in chlorophyll concentrations were typically smaller and later in the season than in 2000 and 2001. The former two years also do not exhibit a fall bloom as seen in the data from the latter two years.

VI. PUBLICATIONS AND REPORTS

The work duration is too short to enable publication in peer-reviewed literature so no such publications are planned. We will submit the required project reports to the Trustee Council Office.

VII. PROFESSIONAL CONFERENCES

Because this work is to develop routines and has a short duration we do not anticipate presenting results at a professional conference.

VIII. PERSONNEL

A. Principal Investigator (PI)

W. Scott Pegau
Kachemak Bay Research Reserve
2181 Homer, AK 99603
ph: 907-235-4799 ext. 6, fax 907-235-4794
email: spegau@coas.oregonstate.edu

B. Other Key Personnel

Terry Thompson will assist in holding the workshop to determine desired remote sensing products. He will also explore avenues to develop an outreach program around remotely sensed data.

Rachel Potter is a technician at UAF that will be responsible for implementing and testing the processing routines. She will also work on the image comparisons in developing the quality control flags.

Dave Musgrave will be Rachel's local supervisor at UAF.

C. Contracts

None

IX. PRINCIPAL INVESTIGATOR QUALIFICATIONS

CURRICULUM VITAE: W. Scott Pegau

Professional Preparation:

University of Alaska, Fairbanks	Physics	B.S./1990
Oregon State University	Oceanography	Ph.D./1996
Oregon State University	Oceanography	Post doc./1996-1997

Appointments:

Senior Scientist, Kachemak Bay Research Reserve (KBRR)	2002-present
Assistant Professor (tenure track), Oregon State University	1999-present

Faculty Research Associate, Oregon State University	1997-1999
Faculty Research Associate (Post Doc), Oregon State University	1996-1997
Graduate Research Assistant, Oregon State University	1990-1996
Research Assistant, University of Alaska, Fairbanks	1987-1990

Current duties:

Current duties at KBRR include maintaining and expanding the in-situ monitoring program, and developing new research programs examining the circulation and primary production in Kachemak Bay and Lower Cook Inlet. I am maintaining a quarter time position at OSU while completing grants from the Navy and NASA to investigate uses of hyperspectral remote sensing data, developing an autonomous underwater vehicle program, and discrimination of phytoplankton taxa using ocean color remote sensing.

Expertise:

My primary area of expertise is the interpretation of in-situ and remote optical measurements to determine types of materials in the water column, determination of vertical distributions from space, water masses, and circulation patterns. I have extensive experience in the conceptual design and deployment of sensors on a number of platforms ranging from traditional cages, ferry vessels, and autonomous vehicles. I also have experience determining heat fluxes using meteorological and oceanographic measurements.

5 recent or significant publications:

Pegau, W. S., Inherent optical properties in the Central Arctic surface waters, in press *J. Geophys. Res.* (in press)

Pegau, W. S., E. Boss, and A. Martinez, Ocean color observations of eddies during the summer in the Gulf of California, *Geophys. Res. Lett.,* ***29***, 10.1029/2001GL014076, 2002.

Weideman, A. D., D. J. Johnson, R. J. Holyer, W. S. Pegau, L. A. Jugan, and J. C. Sandidge, Remote imaging of internal solitons in the coastal ocean, *Remote Sensing of Environment,* ***76***, 260-267, 2001.

Twardowski, M. S., E. Boss, J. B. MacDonald, W. S. Pegau, A. H. Barnard, J. R. V. Zaneveld, A model for estimating bulk refractive index from the optical backscattering ratio and the implications for understanding particle composition in case I and case II waters, *J. Geophys. Res.,* ***106***, 14129-14142, 2001.

Zaneveld, J. R. V., and W. S. Pegau, A model for the reflectance of thin layers, fronts, and internal waves and its inversion, *Oceanography*, ***11***, 44-47, 1998.

X. LITERATURE CITED

Pegau, W. S., E. Boss, and A. Martinez, Ocean color observations of eddies during the summer in the Gulf of California, *Geophys. Res. Lett.*, ***29***, 10.1029/2001GL014076, 2002. This reference examines the use of ocean color to determine surface flow in a region during a time when other remote sensing platforms fail and there is very little oceanographic data collected.

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROJECT BUDGET

Budget Category:	Proposed FY 03
Personnel	$23.7
Travel	$7.4
Contractual	$39.1
Commodities	$0.5
Equipment	$0.0
Subtotal	$70.7
General Administration	$6.4
Project Total	$77.1
Other Funds	$0.0

Comments:

Salary is requested for W. Scott Pegau to be the principal investigator, Katie Gaut to assist in collection and processing of samples for validation efforts, Kim Donohue to coordinate the workshop, and Terry Tompson to assist with the workshop and design a potential public outreach component for the remote sensing data.

Travel funds are requested to attend the EVOS annual meeting in Anchorage and to spend one week in Fairbanks to work with collaborators there in the design of quality control measures. Funds are requested for travel to Homer of the workshop participants. We anticipate 2 persons from Juneau, 2 from Anchorage, 2 from Fairbanks and the rest from the Kenia Peninsula and Kodiak.

Funds are requested for instrument calibration, small boat usage, and supplies to conduct the validation work.

FY03

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8/28/2002

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***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROJECT BUDGET

Personnel Costs:		GS/Range/	Months	Monthly	
Name	Description	Step	Budgeted	Costs	Overtin
W. Scott Pegau	Senior Scientist	18/C	2.0	5.5	
Katie Gaut	Fish Biologist I	14/A	1.0	4.0	
Kim Donohue	Accounting Clerk I	9/B	1.0	3.2	
Terry Tompson	Education Specialist I	19/A	1.0	5.5	
	Subtotal		5.0	18.2	C
					Personnel To

Travel Costs:	Ticket	Round	Total	Da
Description	Price	Trips	Days	Per Die
Travel to EVOS annual meeting	0.2	1	4	C
Travel to Fairbanks to meet with collaborators	0.4	1	5	C
Travel for workshop participants				
				Travel To

FY03

Prepared:
8/28/2002

Project Number:
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***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROJECT BUDGET

Contractual Costs:
Description
4A Linkage
TSRB calibration (to ensure accurate validation data)
small boat usage (12 days @ $150/day, access to validation site)
When a non-trustee organization is used, the forms 4A and 4B are required. **Contractual To**

Commodities Costs:
Description
validation supplies
Commodities Tot

FY03

Prepared:
8/28/2002

Project Number:
Project Title: Visible remote sensing of the Gulf of Alaska
Agency: ADFG

New Equipment Purchases:	Number	U
Description	of Units	Pri
Indicate replacement equipment purchases with an R.	**New Equipment To**	

Existing Equipment Usage:	Numb
Description	of Un

FY03

Prepared:
8/28/2002

Project Number:
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Agency: ADFG

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROJECT BUDGET

Budget Category:	Proposed FY 03					
Personnel	$21.6					
Travel	$0.0					
Contractual	$2.0					
Commodities	$5.0					
Equipment	$0.0					
Subtotal	$28.6					
Indirect	$7.2					
Project Total	$35.8					
Other Funds	$0.0					

Comments:
Requested Salaries include 1/2 month for Dave Musgrave to act as the UAF project coordinator and 3 months for Rachel Potter to process images, implement quality control measures, and design the processing routines to be used.

Funds are requested for communication and shipping costs associated with imagery collection and communicating with the project principal investigator.

Supplies include software and computer supplies. A RAID disk expansion is needed for data storage.

Indirect costs are calculated at the agreed 25% of total direct costs.

FY03

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8/28/2002

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Name: UAF

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROJECT BUDGET

Personnel Costs:				Months	Monthly	
	Name	Description		Budgeted	Costs	Overtin
	Dave Musgrave	Associate Professor		0.5	7.8	
	Rachel Potter	Research Assistant		3.0	5.9	
		Subtotal		3.5	13.7	C
						Personnel To

Travel Costs:		Ticket	Round	Total	Da
	Description	Price	Trips	Days	Per Die
					Travel To

FY03

Prepared:
8/28/2002

Project Number:
Project Title: Visible remote sensing of the Gulf of Alaska
Name: UAF

***EXXON VALDEZ* OIL SPILL TRUSTEE COUNCIL**
PROJECT BUDGET

Contractual Costs:
Description
Communications
shipping
Contractual To
Commodities Costs:
Description
computer supplies and software
RAID disk expansion
Commodities Tot

FY03

Prepared:
8/28/2002

Project Number:
Project Title: Visible remote sensing of the Gulf of Alaska
Name: UAF

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROJECT BUDGET

New Equipment Purchases:	Number	U
Description	of Units	Pri
Indicate replacement equipment with an R.	**New Equipment To**	

Existing Equipment Usage:	Numb
Description	of Un

FY03

Prepared:
8/28/2002

Project Number:
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