COASTAL MARINE INSTITUTE PROGRAM YEAR 10 QUARTERLY REPORT 3

for the period

January 1, 2004 – March 31, 2004



A Cooperative Program between the **University of California** and the

Minerals Management Service

April 9, 2004

COASTAL MARINE INSTITUTE PROGRAM YEAR 10

and

SOUTHERN CALIFORNIA EDUCATIONAL INITIATIVE PROGRAM YEAR 15

QUARTERLY REPORT 3

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University of California

and the

Minerals Management Service

Russell J. Schmitt Program Manager

Coastal Research Center Marine Science Institute University of California Santa Barbara, California, 93106-6150

April 9, 2004

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Program Manager's Report

for the period January 1, 2004 – March 31, 2004

This constitutes the quarterly report for the second quarter for Program Year 10 of the Coastal Marine Institute, a cooperative research agreement between the Minerals Management Service, the state of California and the University of California. As of this quarter, 17 projects currently are being conducted under the aegis of the Coastal Marine Institute.

Actions Pending MMS Approval:

• Please note that PI Washburn, require MMS assistance in securing access to a new HF radar site Task 85386, Contract No. 14-35-01-00-CA-31063, Observing the Surface Circulation in the Eastern Santa Barbara Channel using high frequency radar and Lagrangian drifters;

Major Programmatic Progress and Actions during the Quarter:

- Task 13096: Utilization of Sandy Beaches by Shorebirds: Relationships to Population Characteristics of Macrofauna Prey Species and Beach Morphodynamics, has been completed. The Final Study Report will be submitted to MMS during the next quarter;
- Task 15115: Effects of Temporal and Spatial Separation of Samples on Estimation of Impacts, a Draft Final Report has been submitted to the Coastal Marine Institute, which will be formatted and submitted to MMS during the next quarter;
- Task 17601: Habitat Value of Shell Mounds to Ecologically and Commercially Important Benthic Species, a Draft Final Report has been submitted to the Coastal Marine Institute, which will be formatted and submitted to MMS during the next quarter;
- Task 17605: *Population Dynamics and Biology of the California Sea Otter at the Southern End of its Range*, field work has been completed; a Draft Final Report is being prepared and will be submitted to the Coastal Marine Institute during the next quarter;
- Task 17606: *Population Genetics of Surfgrass (<u>Phyllospadix torreyi</u>) for use in restoration, a Draft Final Report is being prepared and will be submitted to the Coastal Marine Institute during the next quarter.*
- Task 17608: Observing the Surface Circulation along the South-Central California Coast Using High Frequency Radar: Consequences for Larval and Pollutant Dispersal, a Draft Final Report has been submitted to the Coastal Marine Institute, which will be formatted and submitted to MMS during the next quarter;
- Task 18211: Oil Slicks in the Ocean: Predicting their Release Points Using the Natural Laboratory of the Santa Barbara Channel; the Draft Final Report will be submitted during the next quarter;
- Task 18213: Use of Biological Endpoints in Flatfish to Establish Sediment Quality Criteria for Polyaromatic Hydrocarbon Residues and Assess Remediation Strategies, field work has

been completed; a Draft Final Report is being prepared and will be submitted to the Coastal Marine Institute during the next quarter.

Task 14181: *Population Trends and Trophic Dynamics in Pacific OCS Ecosystems: What Can Monitoring Data Tell Us?*

Principal Investigators: Russell J. Schmitt, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, CA 93106 and Andrew J. Brooks, Coastal Research Center, Marine Science Institute, University of California, Santa Barbara, CA 93106

Major Accomplishments, January 1, 2004 – March 31, 2004

Publications and Presentations:

We are currently preparing two papers for publication.

List of all personal associated with the project:

<u>PIs</u> :	Dr. Russell J. Schmitt Dr. Andrew J. Brooks
Graduate students:	Sarah Lester
Post-graduate researchers:	Keith Seydel
Staff research technician:	Corrine Kane

Future Plans:

Work will proceed as proposed.

Problems Encountered:

None

MMS Action Required:

None

Project Year 1:	100%
Project Year 2:	100%

Project Year 3:	100%
Project Year 4:	100%
Project Year 5:	91%

Task 15115: Effects of Temporal and Spatial Separation of Samples on Estimation of Impacts

Principal Investigator: Peter Raimondi, Department of Biology, University of California, Santa Cruz, CA 95064

Major Accomplishments, January 1, 2004 – March 31, 2004

The Draft Final Report was submitted to the Coastal Marine Institute and is being formatted which when finished will be submitted to MMS.

Future plans:

Revise Final Report if necessary.

Problems Encountered:

None

MMS Action Required:

None

Estimated Percentage of Budget Expended:

Project Year 1 100% Project Year 2 100%

- **Task 17601:** Habitat Value of Shell Mounds to Ecologically and Commercially Important Benthic Species
- **Principal Investigators: Mark Page**, Marine Science Institute, **Jenifer Dugan**, Marine Science Institute, and **James Childress**, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, CA 93106

Major Accomplishments, January 1, 2004 – March 31, 2004:

During this reporting period, a manuscript on the results of the study was revised submitted for publication to a scientific journal. A draft final report on this study is in preparation.

Future plans:

A draft final report will be completed.

Problems Encountered:

None

MMS Action Required:

A no cost extension was requested for this project.

Project Year 1:	100%
Project Year 2:	93%

- **Task 17605:** Population Dynamics and Biology of the California Sea Otter at the Southern End of its Range
- Principal Investigators: James Estes, Supervisory Wildlife Biologist, USGS-BRD; Terrie Williams, Professor of Biology, University of California, Santa Cruz; Daniel Costa, Professor of Biology, University of California, Santa Cruz; Katherine Ralls, Research Zoologist, Smithsonian Institution; Donald Siniff, Professor of Ecology, Evolution & Behavior, University of Minnesota.

Major Accomplishments, January 1, 2004 – March 31, 2004:

We continue to focus our efforts on writing the Draft Final Report and associated publications this past quarter.

Future plans:

Complete the Draft Final Report for this project.

Problems Encountered:

No problems have been encountered.

MMS Action Required:

No MMS action required.

Project Year 1	100%
Project Year 2	100%
Project Year 3	100%

Task 17606: Population genetics of surfgrass (<u>Phyllospadix torreyi</u>) for use in restoration.

Principal Investigators: Scott Hodges, Department of Ecology, Evolution and Marine Biology, Douglas Bush, Marine Science Institute, Sally J. Holbrook, Department of Ecology, Evolution and Marine Biology, and Daniel Reed, Marine Science Institute, University of California, Santa Barbara, CA 93106

Major Accomplishments, January 1, 2004 – March 31, 2004:

We continue to focus our efforts on writing the Draft Final report and associated publications this past quarter.

Future plans:

We will finalize and submit our Draft Final Report in the next quarter.

Problems Encountered:

We have not encountered any problems during this quarter.

MMS Action Required:

None

Project Year 1:	100%
Project Year 2:	96%

Task 17607: Public Perceptions of Risk Associated with Offshore Oil Development

Principal Investigator: Eric R.A.N. Smith, Department of Political Science, University of California, Santa Barbara, CA 93106

Major Accomplishments, January 1, 2004 – March 31, 2004:

Because of the recent interest in the issue of increasing oil and gas development in the national forests in California, we prepared a short report on public attitudes on the question. The paper, "Public Support for Oil and Gas Drilling in California's Forests and Parks," was completed and sent to MMS for comment. In brief, we found that attitudes toward drilling in parks and public forests are quite similar to attitudes toward drilling for oil along California's coast. The implication is that drilling for oil and gas in our national forests has the potential to develop into a major controversy, similar to the controversy surrounding offshore drilling along the California coast and drilling in Alaska's Arctic National Wildlife Refuge.

We are also working on a paper investigating the dimensionality of the egalitarianism and individualism measures that we have used in previous publications and reports. We have completed a first draft of the paper, but we need to use more sophisticated missing data imputation methods before sending a copy to MMS. The central finding in this project is that the egalitarianism and individualism measures seem to be independent for people with low levels of political knowledge, but seem to nearly identical for people with high levels of knowledge.

Our proposal to present a paper at the upcoming American Association for Public Opinion Research meetings in May, 2004 was accepted. Our paper, "Public Opinion about Energy Development: Nimbyism vs. Environmentalism" will compare Californians' support for oil drilling off the Santa Barbara coast, off a remote portion of the California coast, and in Alaska's ANWR. Our preliminary findings indicate that support for oil drilling is almost entirely explained by environmental attitudes. We have not yet found any evidence that NIMBYism ("Not in My Backyard" attitudes) has any influence on support for or opposition to oil development. We will submit a copy of the paper to MMS in April.

Future Plans:

We plan to complete the papers described above, and prepare the final report for this project by the end of the quarter.

Problems Encountered:

None

MMS Action Required:

None

Project Year 1:	100%
Project Year 2:	100%
Project Year 3:	98%

- **Task 17609:** Advancing Marine Biotechnology: Use of OCS Oil Platforms as Sustainable Sources of Marine Natural Products
- Principal Investigators: Russell J. Schmitt, Department of Ecology, Evolution and Marine Biology, Jenifer Dugan, Marine Science Institute, Scott Hodges, Department of Ecology, Evolution and Marine Biology, Robert Jacobs, Department of Ecology, Evolution and Marine Biology, Mark Page, Marine Science Institute, Leslie Wilson, Department of Molecular, Cellular and Developmental Biology, and Stephen Gaines, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, CA 93106

Major Accomplishments, January 1, 2004 – March 31, 2004:

ECOLOGY

During this quarter we continued analyses and interpretation of data on the association of geographic and environmental factors with recruitment patterns observed at offshore oil platforms in the Santa Barbara Channel. The results of these analyses are being incorporated into a draft manuscript for publication. Data analyses and interpretation of invertebrate communities on the platforms from photoquadrat sampling continued. This component of the study will form the basis for a second manuscript.

In response to an invitation by the organizers, we presented a paper on our findings from this study in a special session at Aquaculture 2004 (early March 2004) on the culture of pharmaceutically important species.

Future Plans:

Two manuscripts are being prepared for publication, one on the results from recruitment studies and a second on the results from photoquadrat sampling of the platforms. In addition, we will continue to collect specimens of selected invertebrates for genetic and pharmaceutical analyses, in coordination with the other research groups collaborating on this project.

PHARMACOLOGY

Fresh samples were extracted from *Waterispora Cucullata* (WC) and assayed on HeLa S3 cells for evaluation on cell proliferation and viability. Organic extraction techniques were optimized by Daniel Day (Jacobs' lab) and substantial quantities were extracted and purified in order for them to be tested at the Wilson Lab.

Drugging of HeLa S3 Cells with crude (WC-1) and partially purified (WC-2) marine natural product extracts from <u>Waterispora Cucullata.</u>

Results

Inhibition of Cell Proliferation and Viability

Plots were made of % inhibition of cell proliferation (average of 2 samples) vs. drug concentration. % inhibition data are shown in figures 1 and 2. IC50 values were approximated from plots and determined to be 12 μ g/ml for WC1 and 16 μ g/ml for WC2. Cell viabilities were determined for each drug concentration by trypan blue dye exclusion and were found to be equal or less than controls in all cases (control viability 98.9%)

Mitotic Index, Spindle and Chromosome Abnormalities

The mitotic index was determined from DAPI-stained coverslips of untreated and drug treated samples. (Table 1). A 3 fold increase in mitotic index was seen in the two highest WC1 samples but the mitotic index of the WC2 sample was slightly below that of the control. A high percentage of mitotic cells on the WC1 treated coverslips were noted to have abnormal chromosome distributions (Figures 1 & 2). The most common abnormal cell type was a mitotic cell with a distinguishable metaphase chromosome alignment but with 1 or more chromosomes stuck at the pole. Several years ago Mary Ann Jordan developed a classification scheme for these where she grouped the abnormal cells as having either type I, type II or type III spindles. (Jordan et al. 1992 J. Cell Science 102:401-16). Type I spindles have elongated astral microtubules (we suspect most of these were supposed to be kinetochore microtubules but never made the right connections) and a metaphase chromosome distribution with one to 4 chromosomes at the pole. Type II spindles have a shorter than normal interpolar distance (although still with long astral microtubules) and more than 4 chromosomes at the poles but still have recognizable metaphase accumulation of the majority of chromosomes at the equator. Type III spindles form a ball of chromosomes as a result of a collapse of the spindle into a monoastral configuration in place of the normal bipolar orientation. We have observed these types of cells as a result of treatments with drugs such as the Vinca alkaloids, podophyllotoxin, and taxol type compounds. This morphology is observed when nanomolar concentrations of these drugs are used; concentrations that do not alter microtubule polymer mass. From studies of interphase cells treated with these concentrations of drugs we know that microtubule dynamic instability is being suppressed by these drugs at these concentrations.

Most of the abnormal cells in WC1 treated cells fell into the category of type I and type II spindles. The proportion of type I and type II mitotic spindles to total metaphase cells was determined and is reported in Table 1. The abnormal mitotic cells were rare in control populations and were not observed in WC2-treated cells. Also notable was the lack of increased numbers of multipolar spindles in WC1-treated cells (HeLa cells spontaneously develop 1-2% of these as a proportion of total mitotic cells but no increase in this number was seen in WC1 treated cells-data not shown). Multipolar spindles are common in cells treated with compounds like taxol and epothalone B, but not with Vincas and other drugs that at higher concentrations cause microtubule depolymerization. I think we can safely conclude that the crude extracts contain at least one compound that promotes microtubule stabilization in a manner similar to that of the Vinca alkaloids.

Table 1: The mitotic index was determined from DAPI-stained coverslips of untreated and drug treated samples. The proportion of type I and type II mitotic spindles to total metaphase cells was determined and is reported in this table.

Treatment	Mitotic Index	Type I spindles/total metaphase	Number of cells counted
0.2% DMSO	4.4	0.03	606
WC1 (40 µg/ml)	13.5	0.79	572
WC1 (20 µg/ml)	13.3	0.72	563
WC2 (20 µg/ml)	3.4	0	500

Figure 1



% Inhibition of HeLa Cell Proliferation by WC-1

Figure 2



% Inhibition of HeLa Cell Proliferation by WC-2

GENETICS

We have continued to make progress on determining the genetic variation among samples of *Bugula neritina* during this last quarter. Primarily, we have worked to analyze DNA sequence variation for the mtDNA segment we have PCR amplified. As reported earlier, we have identified one new variant thus far but await the complete analysis of all of our samples. We have also designed a new pair of primers for amplification from the bacterial symbiont in order to assess whether the new *B. neritina* clade also harbors a unique lineage of symbionts (one that may produce a unique Bryostatin compound). Our progress was slowed somewhat by our technician leaving the laboratory.

Future Plans:

During the next quarter we plan to fill the open position in the laboratory, re-amplify and sequence the few mtDNA sequences that were difficult to interpret and to begin amplifying and sequencing DNA from the bacterial symbiont from members of each major *B. neritina* mtDNA clade.

Problems Encountered:

None

MMS Action Required:

None

Project Year 1:	100%
Project Year 2:	88%

Task 17610: Joint UCSB-MMS Pacific OCS Student Internship Program

Principal Investigators: Jenifer Dugan, Coastal Research Center, Marine Science Institute, University California, California. 93106, and Edward A. Keller, Environmental Studies Program, University of California, Santa Barbara, California, 93106

Major Accomplishments, January 1, 2004 – March 31, 2004:

A total of four interns worked on MMS and MMS/CMI projects during Winter '04. Jennifer Klaib continued to assist Ms. Dunaway of MMS and Dr. Engle of UCSB with the development and implementation of the MARINE website during this quarter. Funding from the UCSB Shoreline Preservation Fund was used to support three undergraduate student interns during this period. Justin Hoesterey, Sabrina Beyer and Rachelle Fisher were mentored by Drs. Page and Dugan of UCSB in analyzing samples of potential fish prey from platforms and natural reefs. The funds from the Shoreline Preservation Fund were completely expended during this quarter. One new internship was advertised during this quarter but was not filled. We are working with Fred Piltz and other MMS personnel to arrange additional internship opportunities for MMS and MMS/CMI projects during Spring 2004.

No Information Transfer Seminars were requested by MMS during this period.

Future Plans:

Work will proceed as proposed.

Problems Encountered:

None

MMS Action Required:

None

Project Year 1:	100%
Project Year 2:	100%
Project Year 3:	45%

Task 17611: Simulation of a Subsurface Oil Spill by a Hydrocarbon Seep (SSOS-HYS) andTask 18211: Oil Slicks in the Ocean: Predicting their Release Points Using the NaturalLaboratory of the Santa Barbara Channel

Principal Investigators: Jordan Clark, Department of Geological Sciences, **Bruce Luyendyk**, Department of Geological Sciences, and **Ira Leifer**, Institute of Crustal Studies, University of California, Santa Barbara, California 93106

Major Accomplishments, January 1, 2004 – March 31, 2004:

Summary

During the most recent quarter (Winter), efforts have focused on improvements in the bubble model, manuscript writing, and video analysis including new video acquired of very oily droplets.

Bubble measurements

Further video analysis of several vents was conducted. Also, spectral analysis of the emission flux at several vents was analyzed for revisions of a manuscript (*Leifer and Boles*, 2004).

Air Pollution

Air pollution and latitude and longitude data from the late summer air pollution cruise was finished being entered into a Matlab data file to allow mapping and calculation of plume parameters.

Modeling

Modeling errors associated with the mistaken removal of one of the differential equations describing pressure in the bubble have all been addressed. Currently, the model is being tested for its ability to simulate bubbles over a range of depths, from 20 m to 2000 m.

Dissemination

A manuscript on the dynamic nature of seeps including the bubble distributions measured under CMX-37 and the survey mappings over the last three years has been revised and is accepted (Leifer et al., 2004). A paper on the temporal variability of hydrocarbon seep on second order time scales using bubble measurement observations has been submitted to an American Association of Petroleum Geologists (AAPG) memoir Leifer and Boles (2004). A paper investigating the relationship between bacterial community structure in the seep sediment and gas flux has been accepted (La Montagne et al., 2004).

References:

- La Montagne, M.G., I. Leifer, S. Bergmann, L.C. Vandewerfhorst, and P.A. Holden, 2004. Bacterial diversity in marine hydrocarbon seep sediment. *Environ. Microbiol. (accepted)*.
- Leifer, I., J. Boles, J.F. Clark, and B. Luyendyk, 2004. Measuring the dynamic nature of marine hydrocarbon seepage. *Env. Geol.*, (*accepted*).
- Leifer I., and J. Boles, 2004. Measurement of hydrocarbon flow through fractured rock and unconsolidated sediment of a marine seep. *AAPG Memoir*, (*submitted*).

Future Plans:

Work will proceed as proposed.

Problems Encountered:

None

MMS Action Required:

None

Project Year 1:	100%
Project Year 2:	92%

Task 18212: Transport over the Inner-Shelf of the Santa Barbara Channel

Principal Investigator: Carter Ohlmann, Institute of Computational Earth System Science, University of California, Santa Barbara, California 93106

Major Accomplishments, January 1, 2004 – March 31, 2004:

The primary goals of this research are to collect surface current data over the inner-shelf of the Santa Barbara Channel with Pacific Gyre's "Microstar" Lagrangian drifters, and use the data to: identify characteristic features of the flow field such as convergences, divergences and cross shelf transports, determine the surface velocity and velocity variance distributions, examine flow patterns on scales that are too small to be resolved in CODAR current measurements, and investigate how well particle paths determined from Eulerian CODAR fields represent measured Lagrangian flows.

The primary achievements for the quarter (Winter '04) relate to data processing, analysis and presentation of results. Specifically,

- Data processing codes were revisited and more fully automated.
- Data analysis programs were coded to analyze flow statistics.
- Analyzed data were presented to colleagues and manuscripts considered.

With the project coming to completion in October, data collection activities have been halted in favor of analysis. Data processing codes have been rewritten to be more fully automated, to properly handle repeated deployments of drifters during a single day, and to consider the case of drifters being "stopped" by kelp beds. Plots of the processed data have been created and made accessible to others via the web. The short drifter tracks collected do not resolve a complete tidal cycle. Therefore, other data and a tidal model were incorporated to resolve tidal signals. A considerable effort went into understanding and modeling tides using a combination of high frequency radar data and the Matlab t-tide package. De-tided data are necessary for dynamic analyses.

The combination of h.f. radar and drifter data have led to a significant research finding. Much of the "error" previously reported in h.f. radar data is the result of comparisons over different scales. Detailed comparisons between drifter and h.f. radar derived currents, made possible by this high-resolution drifter study, show that agreement between CODAR and drifters is a strong function of the drifter velocity variance within each radar grid cell. This result clearly indicates the importance of sub-gridscale motions when determining transport pathways from Eulerian h.f. radar fields. These sub-gridscale motions are presently being considered.

Budgetary Issues: Funds have been used for boat costs (and accompanying personnel) associated with the drifter deployments (and recoveries), for coding the drifter monitoring and data processing systems, and for data analysis coding. A mid-level computer programmer has been hired on a part-time basis to help with the complex (Lagrangian) computer coding required for proper data analysis.

Future Plans:

Work will proceed as proposed.

Problems Encountered:

None

MMS Action Required:

None

Future Plans:

Work will proceed as proposed.

Project Year 1:	100%
Project Year 2:	65%

Task 18213: Use of Biological Endpoints in Flatfish to Establish Sediment Quality Criteria for Polyaromatic Hydrocarbon Residues and Assess Remediation Strategies

Principal Investigator: Daniel Schlenk, Department of Environmental Sciences, University of California, Riverside, Scott Steinert CSC, Marine Sciences Department

Major Accomplishments, January 1, 2004 – March 31, 2004

Progress has been made towards the final report, which will be submitted to the Coastal Marine Institute next quarter.

Future Plans:

Complete and submit the final report.

Problems Encountered:

None

MMS Action Required:

None

Project Year 1	100%
Project Year 2	100%

Task 18234: Spatial and temporal variation in recruitment to rocky shores: Relationship to recovery rates of intertidal communities

Principal Investigators: Pete Raimondi, Department of Ecology and Evolution, University of California, Santa Cruz, CA. and **Rich Ambrose,** School of Public Health, Department of Environmental Sciences, University of California, Los Angeles, CA.

Major Accomplishments, January 1, 2004 – March 31, 2004:

Recruitment

Recruitment surfaces were sampled and exchanged at Point Sierra Nevada, Stairs and Point Fermin. This took place during the mid-month tide series of January, February and March. Safety-walk plates and tuffies were exchanged for *Chthamalus* and *Mytilus* recruitment, respectively. The *Endocladia* and *Silvetia* collectors were exchanged in January and February but left out in March: a two-month collection period will now be used for the algae recruitment due to their very small size at settlement. Both collectors and natural recruitment were sampled during the month that they were left out. *Silvetia* zygotes were detected on the *Silvetia* collectors at Stairs and Point Sierra Nevada. *Silvetia* recruits were detected in the natural recruitment plots of *Endocladia* in the *Silvetia* zone at Stairs and Point Sierra Nevada.

Recovery Plot Sampling

Recovery plots were sampled at all three sites from March 11th-19th. A Uniform Pt. Contact (UPC) grid was used to quantify percent cover of each recovery plot and three control plots in the *Chthamalus*, *Endocladia*, *Silvetia* and *Mytilus* zones. Mobile invertebrates were counted in each recovery and control plot. Photographs were taken of all plots at all sites using a digital camera and photo-framer with the exception of Pt Fermin, where a Nikonos underwater camera was used to take all photographs.

Future plans:

Recruitment collectors will be exchanged and natural recruitment sampled in adjacent plots every month at all three sites. Cleared plots will be sampled every three months.

List of all personal associated with the project:

Principal Investigators:	Richard Ambrose and Peter Raimondi
Technician/Graduate Student:	Tish Conway-Cranos

Problems Encountered:

None

MMS Action Required:

None

Project Year 1:	~ 1%
Project Year 2:	~ 25%

Task 85338: Weathering of oil and gas in the coastal marine environment: quantifying rates of microbial metabolism

Principal Investigator: David Valentine, Department of Geology, University of California, Santa Barbara, California 93106

Major Accomplishments, January 1, 2004 – March 31, 2004:

Large quantities of oil and gas are released into the Santa Barbara Channel by way of natural seepage with lesser amounts emitted during petroleum removal and recovery. These emissions greatly affect beach, air and water quality along the Southern California Coast. As a result many studies and a substantial amount of resources have been devoted to developing a better understanding of the weathering processes occurring in hydrocarbon-rich environments. These studies have provided evidence for natural hydrocarbon-consuming communities thriving in heavily contaminated regions. It is assumed that native assemblages of microorganisms having the capability to consume a variety of hydrocarbons emitted from natural oil seeps are present in the Santa Barbara channel. Although microbial oxidation is known to occur, little is known about the distribution of relevant microbial communities, rates of oxidation and the extent to which various hydrocarbons are broken down or consumed.

This MMS-UC CMI funded research focuses on the microbial weathering of aromatic compounds released into marine environments. The objectives of this research include: (1) determing the intermediates and end products arising from microbial decomposition of these most persistant and harmful hydrocarbons and (2) the development of techniques utilized to quantify rates for microbial consumption and decomposition of aromatic and polycyclic aromatic compounds in marine environments.

(1) The determination of intermediates and end products arising from microbial weathering processes.

We are using two distinct approaches to study the intermediates and end products of hydrocarbon weathering. The first approach is the use of radio-labeled substrates to assess major products of microbial metabolism. We are still developing this approach and have been hampered by problems with our HP 5890 GC. The second technique involves chromatographic technology designed to completely resolve the undefined complex mixture typical of weathered petroleum, so-called two-dimensional gas chromatography. We have begun collaborating with Chris Reddy at Woods Hole Oceanographic Institution, who has helped develop the GC×GC technology. We have run our first experiments and are awaiting results.

(2) The development of techniques used to quantify rates of microbial hydrocarbon consumption.

We have performed our first experiments designed to assess the rates of hydrocarbon weathering. One experiment involved collecting a time series of surface slick samples at Shane Seep, using the slick sampler developed by other MMS-funded scientists (Liefer et al). Samples were collected at the seep and 'down-slick' and represent a rough time series. Samples are being run using GC×GC and we hope this will provide a rough 'total weathering' rate. Depending on the

results of this experiment, future experiments will be designed to key in on just the microbial weathering.

Another experiment began on October 27 when we collected 5 L of sediment from anoxic regions of Shane's seep to be used in a long-term incubation experiment. The sediment was transported back to the lab, while being kept under environmental conditions. The Goal of the project is to meet the objectives described in the above paragraph. Specifically, we intend to assay the weathering patterns and microbial activity in anoxic, sulfidic sediments. The general approach is to incubate hydrocarbon-contaminated seep sediments under controlled conditions while assaying $CO_2/H_2S/CH_4$ production, sulfate consumption, and changes in petroleum composition.

Experimental design

Serum bottles (60 ml) were filled with 10 g of wet anoxic sediment (~9 ml), 30 ml sea water, and a known aliquot (0.1 g) of raw petroleum - leaving ~ 20 ml of head-space volume. The raw petroleum was obtained from platform Holly and should be similar in composition to the petroleum emitted from Shane's seep. We will use a total of 138 bottles, 81 will be analyzed for weathering and 57 bottles will be used as controls. This allows for the analyses, in triplicate, of 27 scheduled time points. Analyses of the samples began at time 0 and will be carried out monthly, or more frequently, depending on microbial activity based on CO_2 production and sulfate consumption.

Experimental procedure

All samples were prepared in a glove bag and transferred to paint cans containing 10-15 ml of a cystiene solution where they will be kept anoxic. In addition to the triplicate samples in the paint cans each one also contains a control. This control contains the same amounts of sediment and seawater but is heat sterilized in an auto-clave. In addition to these controls we will also analyze a blank containing only sediment and seawater at each time point as a reference. A set of oxygen controls was also prepared using serum vials containing reduced resazurin which were sealed in paint cans containing 10-15 ml of cystiene solution. The resazurin can be used as an indicator of oxygen contamination and should alert us in the case of oxygen penetrating the paint cans and serum vials. Serum bottles were capped (with Teflon-lined stoppers), crimped, flushed with Helium and vigorously shaken. Samples are incubating in the dark at near in-situ temperature (17° C). Sample bottles will be harvested in triplicate according to the above schedule. At the time of sampling the headspace will be analyzed for $CO_2/H_2S/CH_4$, and liquid samples will be taken for sulfate, sulfide, DIC and organic acid analyses. Samples will then be frozen and sent to WHOI for GC × GC analysis.

Analytical procedures

Gases (CO₂/CH₄/H₂S) are quantified in the headspace using an agilent Micro GC/TCD at UCSB. Aqueous sulfur (~ sulfate) is quantified by spectrophotometry and ICP-OES from the liquid phase overlying the sediment at UCSB. Organic Acids are to be measured by HPLC at UCSB. DIC will be measured at UCSB. Hydrocarbon composition will be monitored using GC×GC at WHOI.

Results

During the first 120 days of incubation kill controls (autoclaved petroleum, sediment and seawater), experimental blanks (sediment and seawater w/out petroleum) and experimental bottles (petroleum, sediment and seawater) have been analyzed periodically for various markers/indicators of microbial growth. These experiments have focused on quantifying CO₂ in the head-space of the incubation bottles, determining the δ^{13} C of the CO₂ in the head-space and an assay for the production of sulfide. Quantifying CO₂, the end-product of petroleum consumption by microbes, and analyzing the δ^{13} C of that CO₂ will aid in determining the extent of microbial activity. The production of sulfide should indicate both that conditions are sufficient for microbial growth and the presence of sulfate reducers which has been postulated to be a necessary condition for microbial hydrocarbon oxidation.

Analyses performed on the first 4 time series show a steady increase in the quantity of the CO₂ in the experimental bottles. Results from experiments using the isotope ratio mass spectrometer (IR-MS) on the CO₂ in the head-space show a decrease in the δ^{13} C. Analyses performed in December 18, 2003 showed a δ^{13} C value of approximately +3 whereas values from tests performed on experimental bottles on March 24, 2004 showed a decrease in the δ^{13} C to approximately -12.5. The δ^{13} C value determined in the kill controls has been static at approximately - 10. Sulfide assays show an increase in sulfide produced in the experimental bottles from T=0 to T=4. Aqueous sulfide concentrations have increased from below detection to slightly less than 300 μ M in the first 120 days of incubation. Sulfide concentrations in the kill controls have remained below detection throughout the experiment.

Future plans:

We are in the process of analyzing the long-term incubation study designed to broadly assay hydrocarbon weathering patterns, including aromatics. The duration of the experiment is planned for 12-18 months. Samples are sacrificed on a monthly basis and assayed using the methods described above, including the new GC×GC techniques developed at Woods Hole Oceanographic Institution. We have acquired a Beckman DU-65 spectrophotometer and will be analyzing sulfate concentrations on aqueous samples in order to calculate sulfate reduction rates in the experimental bottles. Since microbial activity has been indicated, the first 5 time series will be shipped to WHOI for GC×GC analyses.

Problems Encountered:

We have encountered some technical problems with the HP 5890 used for this project, likely related to the gas jets. We are currently working to resolve this issue before we purchase the RAGA radioactivity detector.

MMS Action Required:

None

List of all personal associated with the project:

Principal Investigator:	David Valentine
Graduate student researcher:	George Wardlaw
Undergraduate student researcher:	Alison Schlosser

Project Year 1:	100%
Project Year 2:	50%

Task 85386: Observations of the surface circulation in the Eastern Santa Barbara Channel using high frequency radar and Lagrangian drifters

Principal Investigator: Libe Washburn, Institute of Computational Earth System Science, University of California, Santa Barbara, California 93106.

Major Accomplishments, January 1, 2004 – March 31, 2004:

During the first quarter of 2004, we continued our studies of the surface circulation in the Santa Barbara Channel. The following research directions were pursued during the quarter: 1) Continued analysis of dispersion trajectories from oil Platform Irene in the Santa Maria Basin; 2) submitted an outline to obtain a permit to operate a HF radar on Anacapa Island; 3) continued analysis of HF radar-derived trajectories in collaboration with Dr. Carter Ohlmann; 4) conducted additional analysis of the large HF radar already acquired.

A major research effort this quarter was the continuation of the analysis of HF radar trajectories around Platform Irene for May through August of 1999 and 2002. May through August is the peak settlement season for bocaccio rockfish and good HF radar coverage was obtained in 1999 and 2002. Work continued on software development to predict surface drifter trajectories from HF radar time series. A principal goal of this project is to estimate where juvenile bocaccio that recruit to oil production platform Irene might have gone had the platform not been in place. Results of this work were presented by Milton Love at the Western Groundfish Conference in Vancouver, British Columbia.

Following up on a visit by Brian Emery and Libe Washburn to Anacapa Island, a draft outline for a special use permit was submitted to Dan Richards of the National Park Service. As was noted previously, the site looks very promising since the combined data from sites at Mandalay, Coal Oil Point, and Anacapa cover much the eastern channel. To do this, additional funding for the installation will be needed since solar power will be required for powering the radar array. Costs for solar power will be mitigated somewhat because the Park Service already has an array in place. Additional solar panels would be added to power the radar system.

Arrangements were made this quarter to operate a HF radar system on private property in Summerland, CA from May through August, 2004. Data from this site should give us excellent coverage over the eastern Santa Barbara Channel for these four months.

Edwin Beckenbach finished his PhD dissertation this quarter; the main topic of his work was the surface circulation in the western Channel.

Analysis of experiment results was carried out in collaboration with Dr. Carter Ohlmann of ICESS, UCSB to explore the hypothesis that the strength of unresolved small scale motions determines the correlation between currents derived from drifters and currents derived from the HF radars. This analysis will continue next quarter.

The following table summarizes the status of articles submitted to refereed journals that are based on MMS-funded research: Papers in press:

Beckenbach, E.H. and L. Washburn. Low frequency waves in the Santa Barbara Channel observed by high frequency radar. *J. Geophys. Res.* (in press)

- Emery, B.M., L. Washburn, and J.A. Harlan. Evaluating radial current component from CODAR high frequency and moored in situ current meters. *J. Atmos. and Oceanic Tech.* (in press)
- DiGiacomo, P.M., L. Washburn, B. Holt, and B.H. Jones. Coastal pollution hazards in Southern California observed by SAR imagery: Stormwater plumes, wastewater plumes, and natural hydrocarbon seeps. *Marine Pollution Bulletin* (re-submitted)

Personnel associated with project:

<u>Principal Investigator:</u> <u>Programmer Analyst:</u> <u>Staff Research Associate:</u> <u>Graduate Students:</u> Undergraduate Student: Libe Washburn Brian Emery David Salazar Edwin Beckenbach & Corinne Bassin Kyle Visin

Future plans:

Efforts will continue to establish a HF radar site on Anacapa Island. Initial visits to the site were promising and efforts will be made to secure Park Service approval and additional funding to establish the site.

Problems Encountered:

None this quarter. In the fall quarter, the decision on our application to install an HF radar site on Rincon Island was deferred indefinitely by the new lessee, Greka Energy. In the principal investigator's opinion this amounted to a denial so the Anacapa site is being pursued. Any assistance MMS could provide to reverse this would be appreciated.

MMS Action Required:

Any assistance that MMS personnel can provide in gaining access to new HF radar sites would be helpful.

Estimated Percentage of Budget Expended:

Project Year 1: 87%

Task 85339: Ecological performance and trophic links: comparisons among platforms and natural reefs for selected fishes and their prey

Principal Investigator: Mark Page, Marine Science Institute, University of California, Santa Barbara, California 93106, Jenifer Dugan, Marine Science Institute, University of California, Santa Barbara, California 93106, Milton Love, Marine Science Institute, University of California, Santa Barbara, California 93106, and Hunter Lenihan, Bren School of Environmental Science & Management, University of California, Santa Barbara, California 93106.

Major Accomplishments, January 1, 2004 – March 31, 2004:

During this reporting period, we continued to sample potential food items of painted greenling, primarily small amphipod crustaceans, monthly at Naples and Mohawk reefs and Platforms Holly and Houchin. Samples were collected by scraping and vacuum sampling in randomly placed quadrats and returned to the laboratory for processing. During this period we also continued to process samples taken in the field to characterize the potential prey available to painted greenling and analyzed preliminary data using multivariate statistics. We also continued to compare the molt rate and molt increment of caprellid amphipods among sites for eventual use in growth and production estimates of this potentially important prey of painted greenling. We met with Ann Bull of MMS in February to provide a project update.

Painted greenling were again sampled at the same locations where invertebrate densities were quantified. Using these fish collections, we estimate mean condition factor (K) for each site and test whether there were differences among regions (east or mid Santa Barbara Channel) and habitat types (reefs and platforms), and determine if there was a relationship between K and invertebrate prey density. We continued to analyze fish gut content data to determine fish selectivity of prey items in the field.

We continued with discussions on the modeling component of our research in which we plan to use the ecosystem-trophic interaction software ECOPATH/ECOSIM. The general goal of our modeling is to estimate how much fish biomass can be produced on POCS oil platforms versus natural rocky reefs. Our efforts during this quarter continued toward structuring the model so that it contains the appropriate species composition and trophic groups, as well as realistic ranges of biomass inputs.

Future plans:

We will continue regular sampling of potential prey and estimation of individual growth rates of amphipods at the study reefs and platforms. With the collected fish samples, we are estimating stomach "fullness" and determining the number and identity of prey items consumed. We will use these data to compare painted greenling diet with available prey at the study reefs and platforms. We will continue our ECOPATH/ECOSIM modeling effort.

Problems Encountered:

None

MMS Action Required:

None

Estimated Percentage of Budget Expended:

Project Year 1: 52%

Task 85340: *Relative importance of POCS oil platforms on the population dynamics of two reef fishes in the Eastern Santa Barbara Channel*

Principal Investigators: Hunter Lenihan, Bren School of Environmental Science & Management, University of California, Santa Barbara, California 93106, and Andy Brooks, Marine Science Institute, University of California, Santa Barbara, California 93106.

Major Accomplishments, January 1, 2004 – March 31, 2004:

Accomplishments during winter 2003 were to extend fish population surveys and fish tagging/recapture studies of *Coryphoterus nicholsi*, the black-eyed goby, at POCS Platform Gina and reference sites at Anacapa and Santa Cruz Islands. We were able to add an additional survey so now we have an excellent a time series of population abundance change at each site. We also re-invented a method for measuring recruitment of gobies and begun surveys of fish recruitment at all sites. A few individual recruits were recorded at one of our island sites on 24 March, but we expect the major episode of recruitment to begin in April-May. We found gobie egg masses at several sites indicating larval dispersal will soon be underway. We are in the process of counting and collecting eggs to look at hatching success in the lab. Finally, we plan to test our fish tethering technique to estimate mortality rates in late spring after we quantify recruitment.

We involved five graduate and four undergraduate students in our research during the winter quarter. We also had two staff personnel volunteer their time on our project.

Personnel associated with project:

Principal Investigators:	Hunter Lenihan and Andrew Brooks
Staff Research Associates:	Matt Kay and Stephaine Mutz
Post-doctoral researcher:	Richard Wilder
Graduate Students:	Cat Mangairdi, Andrew Rassweiler, and Stu Levenbach
Undergraduate Students:	Corinne Kane, Shannon Herrer, Ashley Greenley, and
	Thomas Welche

Future plans:

Plans for spring 2004 include quantifying recruitment, and designing and erecting a predation study. Our first goal is to quantify hatching success. We have decided to attempt this in the field and laboratory. We will measure recruitment using a new and improved technique- counting settlers on transects. Predation mortality of gobies will be assessed through a manipulative experiment involving the tethering of gobies within various experimental treatments (i.e., different depths, habitat types, and predator accessibility). However, predation experiments are likely to be conducted primarily during the summer.

Problems Encountered:

We have not encountered any significant problems except for the occasional lack of access to Platform Gina due to security alerts.

MMS Action Required:

None at the present time but we will be applying for a no-cost extension in the next quarter.

Estimated Percentage of Budget Expended:

Project Year 1: 70%

SOUTHERN CALIFORNIA EDUCATIONAL INITIATIVE PROGRAM YEAR 15 QUARTERLY REPORT 2

for the period

October 1, 2003 – December 31, 2003



A Cooperative Program between the University of California and the Minerals Management Service

January 15, 2004

SOUTHERN CALIFORNIA EDUCATIONAL INITIATIVE PROGRAM YEAR 15 QUARTERLY REPORT 3

for the period

January 1, 2004 - March 31, 2004

A Cooperative Program

between the

University of California

and the

Minerals Management Service

Russell J. Schmitt Program Manager

Coastal Research Center Marine Science Institute University of California Santa Barbara, California 93106-6150

April 9, 2004

Program Manager's Report

for the period January 1, 2004 – March 31, 2004

This constitutes the quarterly report for the second quarter of Program Year 15 of the Southern California Educational Initiative, a cooperative research agreement between the Minerals Management Service, the state of California and the University of California.

As of this quarter, 1 project is currently are being conducted under the aegis of the Southern California Educational Initiative. The SCEI quarterly report has been combined with the Coastal Marine Institute's quarterly report.

Actions pending MMS approval:

• None

Major programmatic progress and actions during the quarter are summarized below for the period of January 1 – March 31, 2004.

• The project, *Early Development of Fouling Communities on Offshore Oil Platforms*, Page and Dugan, PI, was completed and the Draft Final Report will be submitted to MMS during the next quarter.

Early Development of Fouling Communities on Offshore Oil Platforms

Principal Investigators: H. Mark Page, Jenifer Dugan, and Jason Bram, Marine Science Institute, University of California, Santa Barbara, California 93106

Major Accomplishments, January 1, 2004 – March 31, 2004:

We completed the final processing and statistical analyses of data from a manipulative field experiment designed to test whether early successional species inhibit, enhance, or have no effect on the composition and rate of development of the invertebrate assemblage at Platform Houchin. We found that the removal of colonial tunicates had no effect on the amount of open space present or on the cover of the other major space occupiers (amphipod tube mat, encrusting bryozoans, barnacles), although there was a trend of higher cover of encrusting bryozoans when tunicates were removed. When encrusting bryozoans were removed, the amount of open space increased, but cover of the major space occupiers did not differ from controls. In the barnacle removal treatment, only the cover of encrusting bryozoans was significantly higher than the control. A significant effect of depth on the cover of the invertebrate assemblage was found in the barnacle removal treatment where the percent cover of amphipod tube mat decreased with increasing depth. There was a marginally significant increase in the cover of encrusting bryozoans in the tunicate removal treatment with increasing depth. In general, results from this manipulative experiment supported findings from our earlier experiment which indicated that the effects of depth were more important than biological interactions in influencing the rate of development and composition of the assemblage. A manuscript was submitted for publication.

Future plans:

A second manuscript for publication and a draft final study report and are in preparation.

Problems Encountered:

None

MMS Action Required:

Approval of a no-cost extension and fund reprogramming request is needed.

Project Year 1	100%
Project Year 2	100%
Project Year 3	99%