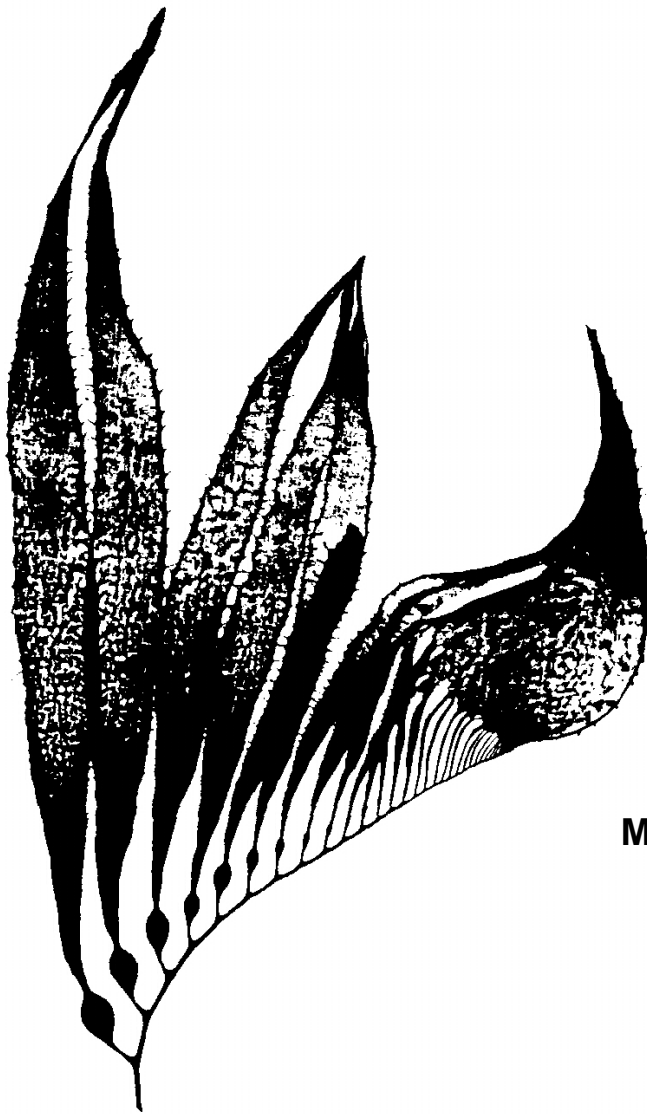


**COASTAL MARINE INSTITUTE
PROGRAM YEAR 11
QUARTERLY REPORT 1**

for the period

July 1, 2004 – September 30, 2004



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

November 2, 2004

**COASTAL MARINE INSTITUTE
PROGRAM YEAR 11**

QUARTERLY REPORT 1

for the period

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A Cooperative Program

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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

November 2, 2004

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Program Manager's Report

for the period July 1, 2004 – September 30, 2004

This constitutes the quarterly report for the first quarter for Program Year 11 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, 18 projects currently are being conducted under the aegis of the Coastal Marine Institute.

Actions Pending MMS Approval:

- ◆ Approval of no-cost extension for Task 17609, Contract no. 1435-01-00-30758, PIs Schmitt, Dugan, Hodges, Jacobs, Page, Wilson, Gaines, *Advancing Marine Biotechnology: Use of OCS Oil Platforms as Sustainable Sources of Marine Natural Products*, through May 31, 2005;
- ◆ Approval of no-cost extension for Task 18234, Contract no. 1435-01-00-30758, PIs Raimondi and Ambrose, *Spatial and Temporal Variation in Recruitment to Rocky Shores: Relationship to Recovery Rates of Intertidal Communities*, through September 30, 2005;
- ◆ 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*;
- ◆ Approval of no-cost extension for Task 85340, Contract no. 1435-01-00-30758, PIs Lenihan and Brooks, *Relative Importance of POCS Oil Platforms on the Population Dynamics of Two Reef Fishes in the Eastern Santa Barbara Channel*, through September 30, 2005;

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* has been completed. The Draft Final Report has been reviewed by MMS we are awaiting comments from the PI;
- ◆ Task 17605: *Population Dynamics and Biology of the California Sea Otter at the Southern End of its Range*; a Draft Final Report was submitted to the Coastal Marine Institute during this quarter. It will be formatted and submitted to MMS in the coming quarter;
- ◆ Task 17607: *Public Perceptions of Risk Associated with Offshore Oil Development*, a Draft Final Report was submitted to MMS.
- ◆ 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 Residue and Assess Remediation Strategies*; a Draft Final Report was submitted to the Coastal Marine Institute during this quarter. The Draft Final Report will be formatted and submitted to MMS in the coming 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, July 1, 2004 – September 30, 2004

A number of entities (including MMS) have devoted considerable effort and resources to the long-term monitoring of various components of the coastal marine ecosystems in the Southern California outer-continental shelf (OCS) region. The primary goals of such monitoring are to estimate the current state of the biota and to identify long-term trends in population demographics. Data from such studies are vital to resource and regulatory agencies as they provide critical baseline information needed for accurate assessment of potential effects arising from such particular activities as offshore oil and gas production. The fundamental need for such information is evidenced by the growing number of coastal marine monitoring programs that have been implemented in Southern California.

Our MMS-UC CMI funded research encompasses two separate objectives: (1) the analysis and synthesis of existing long-term monitoring data and (2) the continued annual surveys of subtidal reef communities at Santa Cruz Island.

(1) The analysis and synthesis of existing long-term monitoring data.

To date we have analyzed 8 separate datasets collected in three different ecological systems; subtidal rocky reef, kelp bed, and open ocean pelagic. Trends in population abundances show consistent declines in all three systems over the last 10-15 years. Most interesting, within each system examined, trends for each component trophic level show approximately the same degree of decline. This pattern holds across spatial scales ranging from a single island within the northern Channel Islands group to the entire Southern California Bight. Also interesting is the fact that data collected using extremely different methodologies, e.g. coastal power plant impingement studies versus diver visual surveys, provide similar estimates of the magnitudes of these declines. Most recently, we conducted time-series analyses on these data sets to describe their temporal trends and explore the timing and magnitude of change. The species examined were classified as to trophic level, mode of reproduction, extent of geographic range, association with benthic or pelagic food webs, and habitat. In general, the magnitude of decline was similar for all species, regardless of classification. Trends were similar at all locations examined within the Bight, suggesting regional declines in abundances rather than redistribution of individuals. These patterns are consistent with the explanation that a regional decline in productivity is responsible for regional decline in fish stocks.

We have now extended our analyses to include almost 30 years of data collected by the National Marine Fisheries Service through their ongoing Resource Assessment and Conservation

Engineering (RACE) groundfish monitoring program. These data come from surveys conducted over the outer continental shelf and allow a comparison of the results we found for shallow, reef-associated species with those of deeper, soft-bottom associated species.

(2) The continued annual surveys of subtidal reef communities at Santa Cruz Island.

We are finishing the process of identifying epifaunal invertebrate samples collected during our 2003 surveys. We continue to monitoring of the abundances of surfperches, their invertebrate prey, and the algal cover present in benthic microhabitats at 11 permanent study sites on the south coast of Santa Cruz Island.

Publications and Presentations:

We are currently preparing two papers for publication as well as a Draft Final Report that will be submitted in the coming months.

List of all personal associated with the project:

PIs: Dr. Russell J. Schmitt
Dr. Andrew J. Brooks

Graduate students: Sarah Lester

Post-graduate researchers: Keith Seydel

Future Plans:

Complete and submit publications and Draft Final Report.

Problems Encountered:

None

MMS Action Required:

None

Estimated Percentage of Budget Expended:

| | |
|-----------------|------|
| Project Year 1: | 100% |
| Project Year 2: | 100% |
| Project Year 3: | 100% |
| Project Year 4: | 100% |
| Project Year 5: | 100% |

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, July 1, 2004 – September 30, 2004

During this reporting period, a Final Report on this study is being revised. The Draft Final report has been reviewed by MMS. We are awaiting comments from the PI's in response to MMS reviews of the report.

Future plans:

Complete Final Report.

Problems Encountered:

None

MMS Action Required:

We require an OCS Study report number for this project.

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, July 1, 2004 – September 30, 2004:

During this reporting period, a Draft Final Report on this study is being revised. The Draft Final report has been reviewed by MMS. A Final Report is being prepared and will be submitted to MMS in the next quarter.

Future plans:

Complete Final Report.

Problems Encountered:

None

MMS Action Required:

We require an OCS Study report number for this project.

Estimated Percentage of Budget Expended:

| | |
|-----------------|------|
| Project Year 1: | 100% |
| Project Year 2: | 100% |

Task 17602: *Inventory of Rocky Intertidal Resources in Southern Santa Barbara, Ventura and Los Angeles Counties*

Principal Investigator: **Richard F. Ambrose**, Department of Environmental Health Sciences and Environmental Science and Engineering Program, University of California, Los Angeles, CA 90095-1772

Lead Technician: Steven F. Lee, M.S. (Dept. of Environmental Health Sciences and Environmental Science and Engineering Program, University of California, Los Angeles, CA 90095-1772)

Major Accomplishments, July 1, 2003 – September 30, 2003:

Work continues and is supported by additional funding by other MMS sources.

Future Plans:

A comprehensive Draft Final Report will be completed at the end of MMS funding cycle (three years).

Problems encountered:

None

MMS Action Required:

None

Estimated Percentage of Budget Expended:

| | |
|--------|------|
| Year 1 | 100% |
| Year 2 | 100% |

Task 17604: *Shoreline Inventory of Intertidal Resources of San Luis Obispo and Northern Santa Barbara Counties*

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

Major Accomplishments, July 1, 2003 – September 30, 2003:

Work continues and is supported by additional funding by other MMS sources.

Future Plans:

A comprehensive Draft Final Report will be completed at the end of MMS funding cycle (three years).

Problems encountered:

None

MMS Action Required:

None

Estimated Percentage of Budget Expended:

| | |
|----------------|------|
| Project Year 1 | 100% |
| Project Year 2 | 100% |

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, July 1, 2004 – September 30, 2004:

The Draft Final Report has been submitted to the Coastal Research Center. We will format the Draft Final Report and submit it to MMS in the next 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.

Estimated Percentage of Budget Expended:

| | |
|----------------|------|
| Project Year 1 | 100% |
| Project Year 2 | 100% |
| Project Year 3 | 100% |

Task 17606: *Population Genetics of Surfgrass (Phyllospadix torreyi) 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, July 1, 2004 – September 30, 2004:

We continued 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

Estimated Percentage of Budget Expended:

| | |
|-----------------|------|
| 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, July 1, 2004 – September 30, 2004:

A Draft Final Report has been submitted to MMS. We are awaiting MMS comments on the Draft Final Report.

Future Plans:

Revise Draft Final Report, if necessary and produce Final Report.

Problems Encountered:

None

MMS Action Required:

We require MMS comments and an OCS Study report number for this project.

Estimated Percentage of Budget Expended:

| | |
|-----------------|------|
| Project Year 1: | 100% |
| Project Year 2: | 100% |
| Project Year 3: | 100% |

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, July 1, 2004 – September 30, 2004:

ECOLOGY

During this quarter we continued the 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 international magazine, *Aquaculture Advocate*, we submitted an article entitled, “Use of OCS oil platforms as sustainable sources of marine natural products” for publication in their August issue. This article was based on our presentation at 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

Elemental Analysis of Red Band

Elemental analysis on the bioactive major red band from TLC shown on the previous annual report has been further analyzed and revealed percent composition as follows: Carbon = 70.06%, Hydrogen = 7.25%, Nitrogen = <.05%, Sulfur = 3.8%, Oxygen = 19.35%. The data reveals a highly conjugated molecule consistent with intense color seen.

Protein Association

Preliminary data suggests that the bioactive compound (pigment) is associated with a protein or protein complex. Both SDS-PAGE and NATIVE gel electrophoresis have been utilized to indicate that the small molecule is bound to a distinct protein of about 70kDa (Fig. 1). Figure 1 shows an SDS-PAGE gel run under denaturing conditions. The gel has not been stained with any reagent, yet a single protein (~70kDa) is clearly visible due to association of the bioactive pigment. Figure 2 displays the same gel stained with Coomassie Brilliant Blue R-250. Several proteins are displayed that do not have any affiliation with the bioactive pigment.

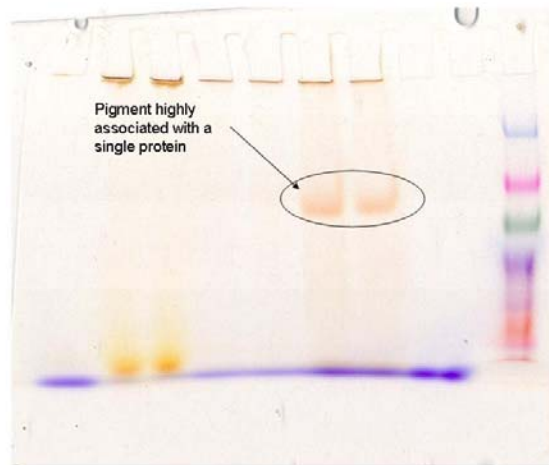


Figure 1. Unstained SDS-PAGE gel showing the affiliation of the bioactive pigment associated with a single protein of 70kDa.

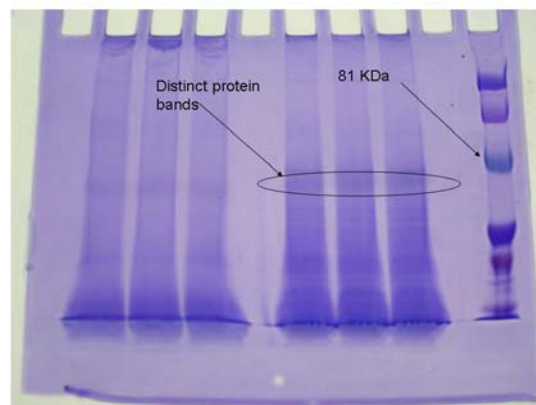


Figure 2. Coomassie stain shows a strong protein band at 70kDa as well as other proteins not affiliated with the colored bioactive compound.

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

Estimated Percentage of Budget Expended:

| | |
|-----------------|------|
| Project Year 1: | 100% |
| Project Year 2: | 95% |

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, July 1, 2004 – September 31, 2004:

A total of six interns worked on MMS and MMS/CMI projects during Summer '04. Kristina Estudillo, mentored by Ms. Mary Elaine Dunaway of MMS, developed educational curricula comparing alternative energy sources with oil and gas for K-12 students. Beth O'Connor, mentored by Dr. Dugan of UCSB, took photos of CMI research projects, developed content, and designed new web pages for the CMI program. New funding from the UCSB Shoreline Preservation Fund was used to support four undergraduate student interns assisting with CMI/MMS research projects during this period. Zuag Yang mentored by Dr. Valentine, assisted with research on hydrocarbons in natural petroleum. Peter White conducted nearshore studies of surface currents using small drifters under the supervision of Dr. Ohlmann. Tom Littlejohn, mentored by Drs. Lenihan and Brooks, assisted with field sampling and growth analyses of fish otoliths. Justin Hoesterey, mentored by Drs. Page and Dugan of UCSB, analysed population structure and composition of potential fish prey from offshore oil platforms and natural reefs. One new internship was advertised and filled during this quarter. We are working with Fred Piltz and other MMS personnel to arrange additional internship opportunities for MMS and MMS/CMI projects during Fall 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

Estimated Percentage of Budget Expended:

| | |
|-----------------|------|
| 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)* and
Task 18211: *Oil Slicks in the Ocean: Predicting their Release Points Using the Natural
Laboratory 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, July 1, 2004 – September 30, 2004:

During this reporting period, a manuscript on the results of the study was revised and accepted for publication to the Marine Petroleum Technology and a second manuscript was revised and accepted to Environmental Geology. A Draft Final Report on this study is in preparation.

Future Plans:

Efforts will be focused on writing the Draft Final Report.

Problems Encountered:

None

MMS Action Required:

None

Estimated Percentage of Budget Expended:

| | |
|-----------------|------|
| Project Year 1: | 100% |
| Project Year 2: | 100% |

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, July 1, 2004 – September 30, 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 relate to quantification of drifter slip, analysis of data, and writing up results. Specifically,

- A drifter was outfitted with two acoustic current meters (Aquadopps).
- Seven Aquadopp-drifter deployments were carried out to quantify drifter slip.
- A draft of the first paper on the project was completed.

Analysis of the drifter data shows that as drifters move closer to shore, their propensity to move in the onshore direction (relative to the along-shore direction) increases. To ensure that this is due to ocean physics, and not drifter slip associated with wave steepening near the shore, a drifter was outfitted with a pair of Aquadopp acoustic current meters to quantify slip. The Aquadopp drifter was deployed on seven different occasions during the period. Results show that slip is less than $1-2 \text{ cm s}^{-1}$, and significant slip values are aligned with wave stress. Thus, the onshore flow near the coast is due to physics and may be an important component of the flow when considering transport of materials to the surf-zone and inter-tidal regions.

Results of the Aquadopp drifter study and the comparison with HF radar data (detailed in a previous report) are the focus of a first paper on the project. The paper entitled "GPS-cellular drifter technology for coastal ocean observing systems" will be submitted to *Journal of Oceanic and Atmospheric Technology* shortly.

Budgetary Issues: Funds have been used for boat costs (and accompanying personnel) associated with the Aquadopp drifter deployments. Salary funds have supported the analysis of data and write-up of the first paper detailing the project and its results.

Future Plans:

Work will proceed as proposed.

Problems Encountered:

None

MMS Action Required:

None

Estimated Percentage of Budget Expended:

| | |
|-----------------|------|
| Project Year 1: | 100% |
| Project Year 2: | 97% |

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, July 1, 2004 – September 30, 2004

Analysis and writing culminated into a Draft Final Report which was submitted to the Coastal Marine Institute this quarter.

Future Plans:

Revise the Draft Final report, if necessary and submit Final Report.

Problems Encountered:

None

MMS Action Required:

None

Estimated Percentage of Budget Expended:

| | |
|----------------|------|
| 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, July 1, 2004 – September 30, 2004:

Recruitment

Safety-walk plates and tuffies were exchanged at Point Sierra Nevada, Stairs and Point Fermin in June, August and September. July was missed due to a scheduling conflict. *Endocladia* and *Silvetia* collectors were exchanged in June at all three sites. Algae collectors and natural recruitment were sampled monthly. *Silvetia* recruits were found in the recruitment plots at all three sites, and on the collectors at Point Sierra Nevada in September. *Endocladia* recruits were detected in plots at Point Sierra Nevada and Stairs.

Recovery Plot Sampling

Recovery plots were sampled at all three sites from June 1st – June 10th. 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.

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

Estimated Percentage of Budget Expended:

| | |
|-----------------|-------|
| Project Year 1: | ~ 1% |
| Project Year 2: | ~ 25% |
| Project Year 3: | ~ 50% |

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, July 1, 2004 – September 30, 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) determining the intermediates and end products arising from microbial decomposition of these most persistent 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 CO₂/H₂S/CH₄ 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 CO₂ 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 CO₂/H₂S/CH₄, 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 $\delta^{13}\text{C}$ 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 $\delta^{13}\text{C}$ 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 $\delta^{13}\text{C}$. Analyses performed in December 18, 2003 showed a $\delta^{13}\text{C}$ value of approximately +3 whereas values from tests performed on experimental bottles on March 24, 2004 showed a decrease in the $\delta^{13}\text{C}$ to approximately -12.5. The $\delta^{13}\text{C}$ 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 μM 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 \times 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 \times 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

Estimated Percentage of Budget Expended:

Project Year 1: 100%

Project Year 2: 100%

Project Year 3: 36%

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, July 1, 2004 – September 30, 2004:

The major accomplishment during this quarter was the successful conduction of an experiment in the eastern Santa Barbara Channel. A major focus of the experiment was observing the near-surface circulation in the region using current-measuring high frequency (HF) radars and in situ instrumentation. Another was to understand oceanographic factors controlling settlement of pelagic juvenile rockfishes on oil production platforms, especially bocaccio.

My research group and I worked closely with Dr. Milton Love's group (of the Marine Science Institute at UCSB) on this experiment. Several oceanographic instruments were mounted on two active oil production platforms in the region, Platforms Gail and Gina including acoustic Doppler current profilers (ADCP's), conductivity-temperature-depth recorders (CTD's), and small thermistors. In addition, juvenile fishes were counted twice per week by SCUBA divers. During the experiment we were fortunate in being allowed to operate a HF radar in Summerland on private property. The experiment had a high data return and was very successful. We are currently working with Milton Love's research group to analyze the data set.

Other research directions pursued during the quarter were:

- 1) completion and submission of a manuscript summarizing our analysis of dispersion trajectories from oil Platform Irene in the Santa Maria Basin. A manuscript entitled "Do oil and gas platforms off California reduce recruitment of bocaccio (*Sebastes paucispinis*) to natural habitat? An analysis based on trajectories derived from high frequency radar" by Brian M. Emery, Libe Washburn, Milton Love, Mary M. Nishimoto, and J. Carter Ohlmann was submitted to Fisheries Bulletin, a peer-reviewed journal.
- 2) continued analysis of HF radar-derived trajectories in collaboration with Dr. Carter Ohlmann. Analyses of observations are being carried 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. An important goal of this research is to assess the accuracy of surface trajectories predicted from HF radar.
- 3) continued analysis of the large HF radar already acquired. A major research effort is to understand northward flowing current events around Pt. Conception when winds relax or reverse. We speculate that they are important in transporting larvae of various organisms northward against the dominant transport of the California Current.

The following paper, supported by MMS funding, was published this quarter:

Emery B.M., L. Washburn, and J.A. Harlan, 2004. Evaluating Radial Current Measurements from CODAR High-Frequency Radars with Moored Current Meters. *Journal of Atmospheric and Oceanic Technology* **21**(8): 1259-1271.

Personnel associated with project:

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

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. Any assistance MMS could provide in securing a HF radar site on Anacapa Island 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:

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|-----------------|------|
| Project Year 1: | 100% |
| Project Year 2: | 94% |

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 – September 30, 2004:

During this reporting period, we finished sampling potential food items of painted greenling 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. We have processed approximately 525 samples of a total of 677 samples taken to date. 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.

Processing has continued on the most recent samples of painted greenling. Data are being collected on fish condition (length and weight), stomach weights, and stomach contents. 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 stomach 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 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 to process samples of potential prey. With the collected fish samples, we will continue to estimate stomach “fullness” and determine 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: | 100% |
| Project Year 2: | 70% |

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, July 1, 2004 – September 30, 2004:

Accomplishments during summer 2003 included finishing fish population surveys and fish tagging/recapture studies of *Coryphopterus nicholsi*, the black-eyed goby, at POCS Platform Gina and reference sites at Santa Cruz Islands. We were able to finish an excellent time series of population abundance change at each site. We also completed a recruitment study and found that the major recruitment period in the Santa Barbara Channel appears to be from June to August. Prior to measuring recruitment, we completed an experiment to detect the per capita production and hatching success of goby eggs at all our site with several sites indicating larval dispersal will soon be underway. Finally, we executed an experiment designed to detect predation mortality.

We involved three graduate and six undergraduate students in our research during the summer period. We also had two staff personnel volunteer their time on our project.

Personnel associated with project:

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

Future plans:

Our next task is to synthesize our information in a population source-sink models. This model, developed by UCSB's Roger Nisbet will allow us to compare the population dynamics of each site and therefore to detect the relative ecological value of one POCS platform, Gina, with three natural rocky reefs habitats. This, our main objective, was a major recommendation of the UC-MMS advisory panel report authored by Holbrook et al. We expect to finish our project and submit papers to scientific journals as early as spring 2005.

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.

Estimated Percentage of Budget Expended:

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|-----------------|------|
| Project Year 1: | 100% |
| Project Year 2: | 97% |