**Offshore Environmental Studies Program**

# Fiscal Years (FY) 2008 – 2010 Studies Development Plan

## Pacific OCS Region

**U.S. Department of the Interior**
**Minerals Management Service**
**Pacific OCS Region**
**Camarillo, CA**
**2007**

# TABLE OF CONTENTS


**SECTION 1.0 PROGRAMMATIC OVERVIEW** **5**

**1.1 Introduction to the Region** **5**

**1.2 Map of Planning Area** **7**

**1.3 Projected OCS Activities** **9**

**1.4 Identification of Information Needs** **11**

**SECTION 2.0 PROPOSED STUDY PROFILES** **13**

**2.1 Introduction** **13**

**2.2 Profiles of Studies Proposed for the FY 2008 NSL** **15**

**Table 1. Proposed Studies and Rankings for FY 2008** **15**

State of the Rocky Shoreline Report– A Report Card on the Health of the Rocky Intertidal Resources in the Santa Barbara Channel **17**

Spatial and Seasonal Variation in the Biomass and Size Distribution of Juvenile Fishes Associated with a Petroleum Platform off the California Coast **19**

California Islands Symposium **21**

Topographic Changes in Rocky Intertidal Habitat Using LIDAR **23**

Predicting Abundance and Distribution of Seabirds and Marine Mammals Under Changing Oceanographic Conditions **25**

Investigation of PCB and PAH Contaminants in Archived Samples of Platform Resident Fish **27**

Comprehensive Relational GIS Database and Web Page for Seabirds, Marine Mammals, Fish, Fisheries and Human Uses off Southern California **29**

**2.3 Profiles of Studies Proposed for the FY 2009 NSL** **31**
Regional Importance of OCS Oil and Gas Platforms as Rockfish Nurseries

**Table 2. Pacific OCS Region Studies Proposed for the FY 2009 NSL** **33**

**SECTION 3.0 TOPICAL AREAS FOR FY 2010** **35**

**SECTION 4.0 LITERATURE CITED** **37**

## SECTION 1.0 PROGRAMMATIC OVERVIEW

### 1.1 Introduction to the Region

The Environmental Studies Program in the Pacific Outer Continental Shelf (OCS) Region started in 1974. The Program has evolved with changes in the geographic areas of concern and study, in the emphasis of disciplines highlighted for research, and change in the status of the area from frontier to a mature producing area (pre-lease to post-lease emphasis).

Existing production and development activities on 43 producing leases offshore southern California will continue for many years. Annual production from these leases is currently 75,000 bbls of oil per day and 140 MMCF of natural gas per day. It is expected that production from the majority of these facilities will continue for many years. The projected OCS activities section of this report fully discusses the activities anticipated on producing leases.

The need for information to regulate future renewable energy projects that may be proposed and implemented in the Pacific OCS Region is reflected in this plan. These energy projects will require studying areas outside Southern California as the interest and resource potential for wind, wave, solar and current energy facilities is throughout the Pacific Coast. For example, wave power is being tested offshore the state of Oregon.

Alternate uses of existing platforms are also being proposed. As the Region has matured, and as developed oil and gas field production has peaked and entered declines, new and innovative ideas for the use of traditional oil and gas platforms have emerged. New uses proposed for oil and gas platforms have included marine aquaculture and Liquefied Natural Gas (LNG) facilities. New or updated environmental studies will support MMS decisions with regard to such innovative and non-traditional uses of offshore facilities. The plan complements and reinforces the Environmental Studies National Strategic Plan.

This document presents a strategy for the Pacific OCS Region. It applies to the entire Region, which stretches from the United States-Mexico border to the border with Canada. It includes Hawaii, only in regards to the earliest planning for possible environmental studies related to renewable energy projects that may occur in the planning area. For FY 2008 and 2009, renewable energy studies are being proposed through the Headquarters Studies Plan. This plan focuses on the Southern California Planning Area (see map inset, figure 1.2). In future years, the regions will take an increasing role in developing appropriate studies to answer critical information needs in the other programs in the next few years; potential topics for alternate use are projected for 2010.

The information obtained through these studies is important and relevant to decision making. This information fulfills the following criteria:

- The study provides significant new or additional information beyond what is already known;

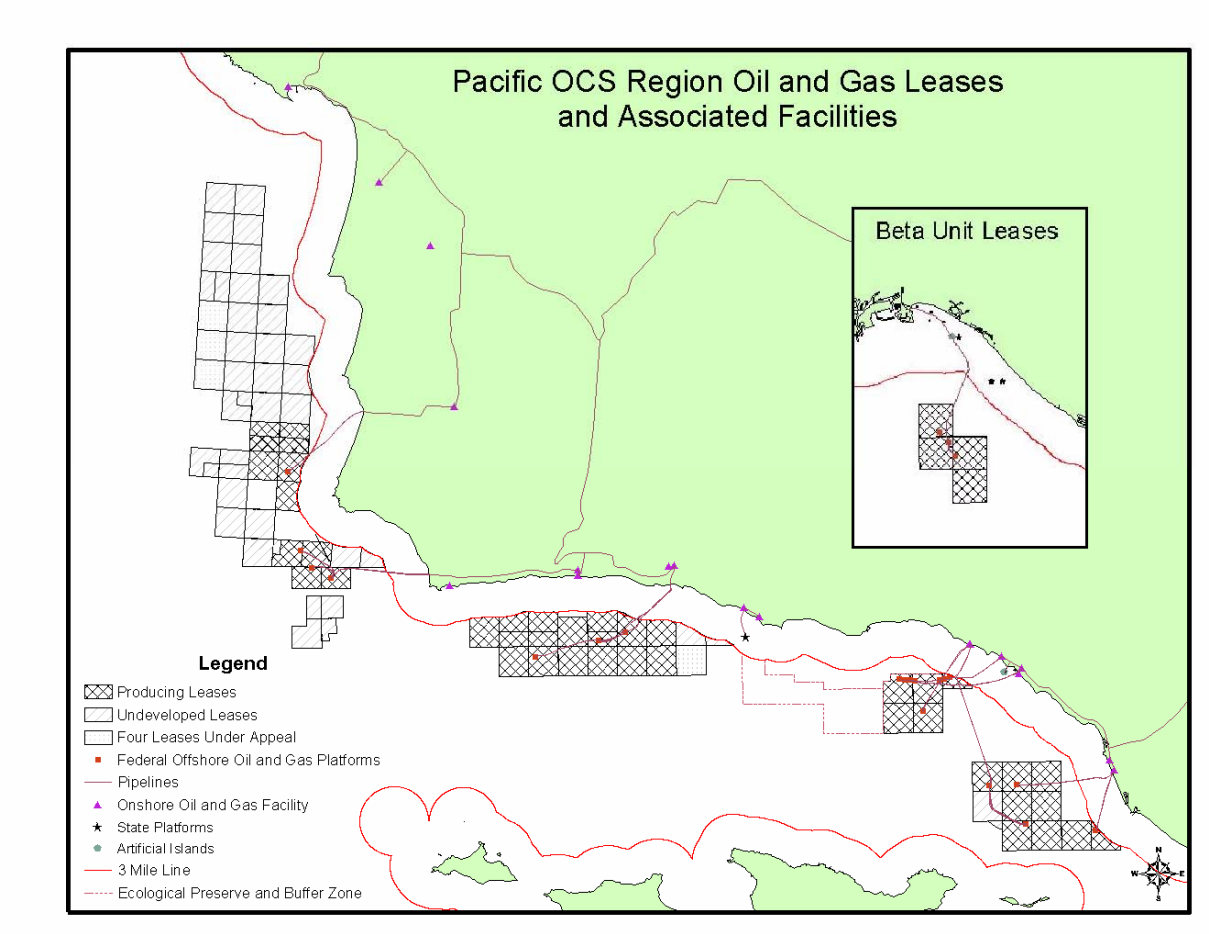
- The identified study is within the financial scope and time frames of the Offshore Program;

- The information provides insight into significant processes critical for understanding both natural and anthropogenic changes;

- The issue can be studied within science's present abilities or understanding of experimental methods to acquire the information.

The level of future OCS oil and gas activities and the introduction of renewable energy projects offshore the Pacific Coast will dictate changes in the strategy. Findings from current or future research may also affect the strategy and cause other avenues of research to be incorporated.

If you have any questions regarding this Pacific OCS Region Environmental Studies Development Plan, please contact Dr. Fred Piltz, Pacific OCS Region at (805) 389-7850 or Mary Elaine Helix at (805) 389-7848. You can also view the Minerals Management Service and Pacific OCS Region home pages at ***www.mms.gov*** for additional information.




## 1.2 Map of Active Leases

## 1.3 Projected OCS Activities

### Prelease

No lease sales are anticipated for this planning area under the MMS Comprehensive Leasing Program for 2008 – 2012 nor are any lease sales projected for the future.

### Postlease

The Southern California Planning area contains

-43 producing oil and gas leases
-600 million barrels of oil in proved reserves on existing producing leases

There are 43 producing leases in the Southern California Planning Area with 23 oil and gas platforms in Federal waters. These leases currently produce 75,000 barrels of oil per day and 140 million cubic feet of natural gas per day; this rate could be sustained into the next decade. Studies identified in this regional plan highlight critical information gaps and are geared to allow MMS to conduct analyses that support permitting and regulation of the oil and gas industry's ongoing production projects. Continued production at these facilities may pose new information needs during the coming decade in order to maintain environmentally safe operations with the existing infrastructure.

Studies are needed to address and monitor the environment adjacent to the existing facilities. For example, environmental studies information was used in analysis for the replacement of a power cable to the Santa Ynez Unit (Santa Barbara Channel) offshore platforms. These platforms are electrically powered from onshore sources via a cable. The cable needed to be replaced and the MMS used recent data from environmental studies in preparing an Environmental Assessment (NEPA document) for that post lease activity.

Several alternate uses of oil and gas facilities have been proposed recently including use of an OCS facility as a receiving port for LNG.

## 1.4 Identification of Information Needs

The main areas of information needs fall into the following categories:

### a. Supporting existing oil and gas production activities.

Biology

--Health of the Rocky Shore.

In support of decisions concerning ongoing drilling and production operations, there is a need to evaluate the monitoring data from shoreline plant and animal populations proximal to producing facilities in a manner which allows managers to determine the overall health of the community. Health indices are being developed; MMS monitored long term rocky intertidal sites in the Santa Barbara Channel would be ranked in report card fashion and reported in a State of the Rocky Shore report for managers and the public. Production from many of these facilities is expected to continue for a number of years. MMS needs to monitor environmental impacts and to maintain a readiness along the shoreline to address potential impacts, including those that may result from accidents from OCS production for the duration of operations. This study will help MMS assess regional impacts from OCS operations throughout the Channel on rocky shores.

--Predicting seabird and marine mammal abundance.

In support of oil and gas operations decisions and in anticipation of needs to assess potential impacts from proposed future alternative energy projects such as offshore windmills, the region is proposing a study which develops a model to predict the distribution and density of marine mammals and seabirds using oceanographic features. The study will collect seabird and marine mammal data (it has been 5 years since regional data have been collected) and physical oceanographic data. A relational model will be developed to predict abundances of seabirds and mammals using data that will become available through the U. S. Ocean Observing System as it is deployed and becomes operational.

--Topographic changes from Light Imaging Detection and Ranging (LIDAR).

LIDAR data are collected currently by Scripps Institute of Oceanography and by Counties/Cities in Southern California for beach nourishment projects. It is simultaneously collected over rocky intertidal habitats but currently these data are not being analyzed. This pilot study, will determine if these data can be used to evaluate changes in rocky intertidal habitat/species, especially along portions of the coastline that cannot be monitored due to inaccessibility and in assessing habitat quality during a rapid response to an oil spill.

### b. Continue to obtain information in advance of potential future decommissioning.

--Spatial and seasonal variation in juvenile fishes.

The Pacific Region has completed several studies which examine abundance of fishes at the platforms in order to assess the impact of removing these facilities. Building on that work, this study would examine how juveniles of the same type species use the habitat while present at platforms. Knowledge of the potential importance of platforms to the recruitment and

survival of depleted rockfish stocks is essential for fully evaluating the various options proposed for decommissioning California's offshore oil platforms.

--Investigating fish contaminants.
The fate of spent offshore platforms and pipelines off California continues to be debated; a recurring concern is the potential for contaminant load on platform resident fish and shellfish. Given a recent spill of PCBs at an OCS platform, this study will look at potential contamination of hydrocarbons and PCBs.

**c. Providing for Information Management**

--GIS database update.
The proposed fully integrated GIS database will provide a detailed summary of the most up to date abundance and distribution information (marine mammals and seabirds) and resource use (fisheries and human use) to enable MMS environmental scientists the capacity for the analysis of potential impacts from and decisions regarding planned and future projects in the Pacific OCS.

--California Islands Symposium
Support for this symposium will allow for better decisions due to timely release of MMS funded research.

# SECTION 2.0 PROPOSED STUDY PROFILES

## 2.1 Introduction

Study Descriptions of Ongoing Studies may be found on the web at http://www.mms.gov/eppd/sciences/esp/profiles/pacific.htm.

**Ongoing Operations Support Studies:**

Three new studies supporting ongoing operations are proposed for FY 2008.

- State of the Rocky Shoreline Report – A Report Card on Health
- Predicting Abundance and Distribution of Seabirds and Marine Mammals Under Changing Oceanographic Conditions
- Topographic Changes in Rocky Intertidal Habitat Using LIDAR.

**Decommissioning Studies:**

Two new decommissioning studies are identified for MMS funding in FY 2008.

- Spatial and Seasonal Variation in the Biomass and Size Distribution of Juvenile Fishes Associated with a Petroleum Platform off the California Coast
- Investigation of PCB and PAH Contaminants in Archived Samples of Platform Resident Fish

**Information Management:**

Two new studies supporting information management functions are identified in FY 2008.

- Comprehensive Relational GIS Database and Webpage for Seabirds, Marine Mammals, Fish, Fisheries and Human Uses off Southern California.
- California Islands Symposium

## 2.2 Profiles of Studies Proposed for the Fiscal Year 2008 NSL

**Table 1. Pacific OCS Region Studies Proposed for the Fiscal Year 2008 NSL**

| Page # | Discipline | Title | Rank |
|---|---|---|---|
| 17 | HE | State of the Rocky Shoreline Report– A Report Card on the Health of the Rocky Intertidal Resources in the Santa Barbara Channel | 1 |
| 19 | HE | Spatial and Seasonal Variation in the Biomass and Size Distribution of Juvenile Fishes Associated with a Petroleum Platform off the California Coast | 2 |
| 21 | IM | California Islands Symposium | 3 |
| 23 | HE | Topographic Changes in Rocky Intertidal Habitat Using LIDAR | 4 |
| 25 | MM | Predicting Abundance and Distribution of Seabirds and Marine Mammals Under Changing Oceanographic Conditions | 5* |
| 27 | IM | Comprehensive Relational GIS Database and Web Page for Seabirds, Marine Mammals, Fish, Fisheries and Human Uses off Southern California | 6* |
| 29 | FE | Investigation of PCB and PAH Contaminants in Archived Samples of Platform Resident Fish | 7* |

AQ = Air Quality
HE = Habitat and Ecology
IM = Information Management
SS = Social Science
FE = Fates and Effects
MM = Marine Mammals and Protected Species
PO = Physical Oceanography

* Targets USGS funding (BRD)

**ENVIRONMENTAL STUDIES PROGRAM: Studies Development Plan FY 2008-2010**

**Region:** Pacific OCS Region

**Planning Area(s):** Southern California

**Title:** State of the Rocky Shoreline Report– A Report Card on the Health of the Rocky Intertidal Resources in the Santa Barbara Channel

**MMS Information Need(s) to be Addressed:** MMS has been monitoring the rocky coastline adjacent to OCS oil and gas activities since 1991 and participating in the study of a larger network of sites across the Pacific coastline for many years. This study is aimed at finding a better way to communicate the data we have been collecting to managers and the public. Another effort currently being conducted by MARINe will identify the health indices to use in determining the health of rocky intertidal sites. The proposed study will take these indices and evaluate the 15 years of data from a subset of the 24 MMS-monitored sites to provide a "report-card" style report on the health of the rocky intertidal communities in the Santa Barbara Channel. This pilot will also identify potential data gaps, and other issues which hinder our ability to assign a "grade" to a site. MMS will use this information to evaluate the cumulative impact from oil and gas activities on the shoreline, and to assess impacts from new activities or accidents from the offshore program.

**Cost Range:** (in thousands) $160 – 240 **Period of Performance:** FY 2008-2009

**Description:**

Background: Several environmental efforts are being undertaken due to the need by managers to understand the overall health of various parts of the ecosystem. This is not a trivial problem, and the reason it has not been addressed is that it is extremely difficult to identify parameters which indicate "health" in the highly complex rocky intertidal system.

Managers, however, as represented by Federal, State and local agencies on the MARINe Steering Committee continue to press toward an answer to the question so that they can make resource based decisions. This is in direct line with the mission of MARINe established in 1997 which is "to determine the health of the rocky intertidal and make this information available to the public". MMS has been interested in developing the information in this context for several years in order to assess the health of the system adjacent to our operations and attempt to understand overall cumulative impacts to the resources.

Currently this need for information is also surfacing in many other related forums—at the Taxonomic Workshop, MARINe was asked by the State Water Quality Control Board to recommend "healthy reference sites" which could be used as controls for determining when habitats damaged by outfalls/storm runoff had returned to a "healthy" condition. The

California Resources Agency, in compliance with the Marine Life Protection Act, is in the process of setting up a system of reserves along the California coast (starting initially in an area studied by MMS) and need to know the same information so as to design proper monitoring programs for set aside reserve areas. The National Park Service (NPS) also has requested MARINe's expertise is establishing health indices for the rocky intertidal as part of a national program to assess the status of resources across their park system. MMS through MARINe has the expertise needed to develop meaningful parameters to measure the health of the sites.

MMS has consistently monitored the rocky shoreline adjacent to OCS activities since 1991 in order to understand potential direct and cumulative impacts from our activities. Substantial information has become available over the past decade which now enables scientists to attempt to evaluate the health of the rocky intertidal system. MMS PIs from our MARINe study agree that we may finally have enough information to identify health indices. An expert panel is made up of intertidal scientists and scientists familiar with developing health indices for other resources has volunteered their time to develop the indices; once developed, these parameters can be used to analyze the data from our sites to determine their overall health and ranking.

Objectives: To use identified health indices developed by MARINe to evaluate data from long term monitoring program site in order to rank the health of MMS- monitored sites in "report card" fashion.

Methods: Trend data and biodiversity data collected at MMS-funded sites, and housed either in the MARINe database or in the PISCO database, will be evaluated to determine the health of the sites in relation to the identified indices. It is expected that the health indices will consider various scientific measurements of biodiversity and robustness of the resources will be considered along with known natural variation along the coast due to physical variables such as exposure, slope, substrate, usage, sand intrusion, etc.

This pilot report will focus on MMS monitored sites in the Santa Barbara Channel/Santa Maria Basin and the corresponding NPS sites on the Channel Islands where we have the longest dataset so a direct comparison can be made between mainland and island sites. A summarized "report card" would be released to the public; an attached, more detailed report would be released for local, state and federal government managers. This report will become a model for future state-wide reports.

Peer review will be built into the development of this report to ensure there is a consensus among experts as to the validity of the rankings. It is anticipated that this peer group will be subset from MARINe with its 40 partners and will contain Sanctuary managers, Park managers, State managers and scientists so that the report strikes a balance between scientific and management goals to maximize its use in public coastal management programs.

**Revised Date:** April 5, 2007

**ENVIRONMENTAL STUDIES PROGRAM: Studies Development Plan FY 2008-2010**

**Region:** Pacific OCS Region

**Planning Area:** Southern California

**Title:** Spatial and Seasonal Variation in the Biomass and Size Distribution of Juvenile Fishes Associated with a Petroleum Platform off the California Coast

**MMS Information Need(s) to be Addressed**: The fate of spent offshore oil platforms in California has been a subject of considerable debate, much of which is focused on the potential importance of the platforms as artificial reef systems. Knowledge of the potential importance of platforms to the recruitment and survival of depleted rockfish stocks is essential for fully evaluating the various options proposed for decommissioning California's offshore oil platforms. The MMS Decommissioning Workshop recommended this study to build upon several completed studies that have collected fish data. Several completed and ongoing studies have or are collecting fish data, and this effort will provide MMS with the data to more accurately prepare environmental documents for decommissioning.

**Cost Range:** (in thousands) $370-550 **Period of Performance:** FY 2008–2011

**Description:**

Background: Debates regarding offshore petroleum platform decommissioning have raised questions about how these structures function in replenishing local fish stocks. Eight species of rockfish, including widow, bocaccio, and cowcod, have been declared overfished by NOAA. Of special concern is the bocaccio which has been proposed as a candidate for listing under the Endangered Species Act and the cowcod, which is a species of special concern to the State of California. Because fish populations are usually limited by available energy, recruitment, or habitat, it is important to determine if platforms provide critical habitat for early life history stages. Results from MMS-funded research during the mid-1990's and early 2000's show that platforms uniquely serve as shallow, offshore habitats that are suitable for recruitment of a number of fish species that also recruit to nearshore natural reefs. Several species, such as bocaccio, widow and blue rockfishes have recruited in far greater numbers to platforms than to most of the natural reefs that have been surveyed. Year after year, researchers from the University of California, Santa Barbara document hundreds of thousands of young rockfish recruiting in pulses to the platforms off California. Often the incredible numbers and species of juvenile rockfish vary widely over short time periods. The importance of the platforms to these pulses, or if there is a pattern to these pulses, is unknown.

Previous studies have used scuba divers, which are limited to survey depths 40 m or less, to estimate juvenile rockfish densities. Divers cannot fully estimate the true abundance of

rockfish recruits due to this depth limitation. Submersible surveys, which have documented juvenile rockfishes down to 180 m depths, are not suitable for this type of study because observers have difficulty identifying juveniles to species (critical due to the 40+ rockfish species found in the area) and the submersibles cannot survey inside the platform jacket, where most of the juvenile fishes reside. This study proposes to apply the proven hydroacoustic methods used previously in the Gulf of Mexico, to determine (1) the number juvenile recruits, (2) the species composition, (3) their size distribution, (4) the depth at which the fishes recruit and reside, and (5) the frequency and intensity of recruit pulses to the rigs. Visual methods will still be used to groundtruth the hydroacoustic signal.

The investigation of the nursery function and recruitment linkage between the reef fish community and offshore oil and gas platforms has obvious and immediate ecological implications, clear ramifications for MMS, fishery management impacts, and direct applicability to California since it has vertically structured platforms offshore.

The MMS-funded study *Assessing the Fate of Juvenile Rockfish at Offshore Platforms and Natural Reefs in the Santa Barbara Channel* NSL PC-04-02, Agreement Number 1435-01-05-CA-35031 was awarded in FY 2004. That investigation focused on a longitudinal snapshot of the fate of juvenile rockfish if platforms were not present. The present study builds upon that work and would examine how juveniles of the same species use the habitat while present at platforms. The MMS Decommissioning Workshop recommended this present study to build upon the prior work.

Objectives: The objectives of this investigation are to 1) Determine the pattern of recruitment pulses over 2-3 rockfish recruitment seasons; 2) Determine the effect of water depth on juvenile fish density, size distribution and species composition; and, 3) Ultimately, measure the recruitment value of a platform.

Methods: A sampling protocol that builds upon the findings and techniques developed by Stanley et al. in the Gulf of Mexico will be used for this project in order to produce time- and cost-effective results. It is expected that hydroacoustic methods will be used to document the assemblage of juvenile fishes over the rockfish recruitment season (May-August) for 2-3 years at one appropriate platform. In addition to the dual beam hydroacoustic array, groundtruthing (visual) estimates that calibrate the hydroacoustic signal will be used to measure the density and size distribution of juvenile fishes, and to determine species of juvenile fishes associated with a petroleum platform off the California coast.

**Revised Date:** April 5, 2007

**ENVIRONMENTAL STUDIES PROGRAM: Studies Development Plan FY 2008-2010**

**Region:** Pacific OCS Region

**Planning Area:** Southern California Planning Area

**Title:** California Islands Symposium

**MMS Information Need(s) to be Addressed:** The Symposium is critical in enabling MMS to make quicker and better decisions on ongoing operations and potential future decommissioning in the Region. Dissemination of the results of MMS funded studies that are the foundation of environmental documents is needed to support the ready acceptance of MMS prepared EIS's and EA's. The Symposium has traditionally served as one of the most effective vehicles in disseminating such MMS research. It also has served as a critical forum for feedback to MMS on the quality of the information generated in the Environmental Studies Program as well as providing added direction to those topical areas that may need additional study.

**Cost Range: (in thousands)** $60-100 **Period of Performance:** FY 2008–2009

**Description:**

Background. The Minerals Management Service Pacific OCS Region has a long history of supporting the transfer of information gained through the Environmental Studies Program to interested users via Information Transfer Meetings (ITMs) and major regional conferences such as the Fifth California Islands Symposium held in Santa Barbara in 1999. The ITMs and the California Islands Symposium have provided a showcase for disseminating the results of studies funded by the MMS to State agencies, local government agencies, non governmental organizations, academia, and the public. MMS Nationwide has benefited from these symposia due the compliments to MMS on their high quality science and for its support of such meetings. At these meetings, scientists working for MMS can be questioned directly by attendees and provide for a dialog with those people that need to understand and use the results of MMS funded research. In the addition, MMS has been able to receive feedback on its Environmental Studies Program over the years and make it more responsive to the information needs of the region decision makers.

The symposium serves as a forum at which MMS can facilitate discussion of ongoing operations, current projects that may be controversial and their decision points, and future decommissioning options. These discussions help diffuse potential controversial options for ongoing projects and for projects such as rigs to reefs through timely presentation of these studies.

Objectives: The Pacific OCS proposes to provide financial and planning support for the next California Islands Symposium and actively involve scientists from MMS funded research in the symposium presentations and poster sessions. The objective is to highlight the research

that has been accomplished under MMS funding related to future offshore oil and gas decommissioning as well as other MMS funded research. For example, MMS would plan to hold a dedicated session to highlight MMS studies focused on habitat mapping and mapping of tar seeps in the Santa Barbara Channel. Another session highlighting the focuses platform fisheries association studies MMS has funded over the past five years is also a likely topic of interest. Additionally, MMS intends to prepare a video summarizing results from MMS studies in the Santa Barbara Channel which could be shown at this event and could be used in other forums beyond this Symposia.

Methods: The Pacific OCS Region will serve as one of several co-chairs of the next California Islands Symposium. Other co-chair organizations already committed are the Channel Island National park and the Channel Islands National Marine Sanctuary (both sponsors and chairs of previous symposia). Funding by MMS will be in conjunction with funding from the National Park Service and direct support from the Sanctuary to provide for the preparation of the proceedings from the symposium, meeting facilities, support for several key note speakers, and preparation of pre-meeting materials. Proceedings of the symposium in digital format and hard copy (limited numbers of hard copies) will be produced. A video summarizing MMS studies in the Santa Barbara Channel will also be produced. Other agencies, such as USGS who is working cooperatively with MMS on several current studies are interested in providing additional support for the video production.

**Revised Date:** April 5, 2007

**ENVIRONMENTAL STUDIES PROGRAM: Studies Development Plan FY 2008-2010**

**Region:** Pacific OCS Region

**Planning Area:** Southern California Planning Area

**Title:** Topographic Changes in Rocky Intertidal Sampling Areas Using LIDAR: A Pilot Data Analysis Study

**MMS Information Need(s) to be Addressed:** The Minerals Management Service Pacific OCS Region has monitored rocky intertidal habitat adjacent to ongoing offshore oil and gas activities for many years. The plants and animals that occupy this ecologically important habitat are most strongly influenced by the shape of the rocky region between high and low tides and the complex small scale topography that structures their physical habitat. MMS scientists have used traditional surveying methods to periodically measure the topography at MMS sampling sites but the methods are time consuming and limited in geographic extent. If LIDAR can be used to map small scale topography in a quick and efficient manner, changes in the rocky intertidal communities driven by physical changes in habitat can be understood and used to interpret spatial and temporal data collected by MINT and MARINe.

**Cost Range: (in thousands)** $75-$125 **Period of Performance:** FY 2008–2009

**Description:**

Background. Tracking the topographic changes in rocky intertidal areas being sampled by MMS and others within the MARINe consortium is presently done via time consuming and spatially limited methods. Tracking such changes over time is crucial to understanding a key factor in determining the initial and successional communities that populate rocky intertidal habitats. Gradual and sudden changes in the topography from storms, sand inundation, slow sea level rise, and human perturbation can create fresh substrate for colonizing organisms, bury existing populations, or move organisms into exposure regimes different from those in which they settled. The use of LIDAR has been routinely employed in several studies of the dynamics of sandy beaches in southern California. LIDAR surveys have been conducted over stretches of the coast that include both sandy beaches and rocky intertidal habitats. The data from these surveys have been successfully analyzed and the results used to measure sandy beach profiles and changes of the beaches with time. The data for the stretches of rocky intertidal habitat have been archived along with the data from sandy areas but these former data have not been analyzed.

Objectives: The objective of this study is to test whether LIDAR surveys can be used as a tool to map changes in topography in rocky intertidal areas that are adjacent to OCS oil and gas operations. If LIDAR can be used successfully to track changes in the complex rocky topography from sand inundation or direct physical storm induced changes, a key factor in

structuring rocky intertidal communities can be more easily and accurately monitored over time.

Methods: Data are already collected and archived during LIDAR aerial surveys of beaches in southern California by the State of California Department of Boating and Waterways. These data would be reviewed for subsets of data collected over rocky intertidal areas along the coast and subsequently the data would be analyzed to develop three dimensional maps of the rocky stretches of coast. These maps would next be compared to ground truth surveys and the accuracy of the LIDAR generated maps assessed. For areas that proved to have larger errors, new analytical algorithms could be explored in order to generate more accurate maps.

**Revised Date:** April 5, 2007

**ENVIRONMENTAL STUDIES PROGRAM: Studies Development Plan FY 2008-2010**

**Region:** Pacific OCS Region

**Planning Area:** Southern California Planning Area

**Title:** Comprehensive Relational GIS Database with Public Web Page Access for Seabirds, Marine Mammals, Fish, Fisheries and Human Uses off Southern California

**MMS Information Needs to Be Addressed:** The proposed fully integrated GIS database will provide a detailed summary of the most up to date abundance and distribution information (marine mammals and seabirds) and resource use (fisheries and human use) to enable MMS environmental scientists to analyze potential impacts from and provide input to decision makers regarding planned and future projects in the Pacific OCS.

**Cost Range:** (in thousands) $240-320 **Period of Performance:** FY 2008–2009

**Description:**

Background: The ocean waters off southern California are subject to environmental threats from activities of more than 16 million people who live along the coast. The region supports a $9 billion economy and receives 100 million tourist visits per year, but is used extensively for offshore oil extraction, oil tanker traffic, commercial shipping, commercial and recreational fishing, and military activities (Straughan 1971, Anderson *et al*. 1993). The potential for environmental threats prompted state and federal efforts to protect and monitor seabirds and marine mammals, and to establish protected marine reserves (Airamé *et al*. 2003).

From 1999-2002, the U.S. Geological Survey (USGS) and Humboldt State University (HSU) worked with MMS to conduct a multi-year study that quantified the at-sea distribution of seabirds and marine mammals. Over 55,000 km were flown, 485,000 seabirds (67 species), 64,000 marine mammals (19 species) were recorded and 1900 locations from 248 radio-marked birds were recorded. Seven client agencies provided matching funds or in-kind support, including the California Department of Fish and Game (CDFG), U.S. Navy (USN), NOAA Channel Islands National Marine Sanctuary (CINMS), NPS Channel Islands National Park (CINP), U.S. Fish and Wildlife Service, Moss Landing Marine Laboratories (MLML), and the Wildlife Health Center (UC Davis). The study provided MMS with updated information on distribution and abundance patterns and compared it to information from the early 1980s (Hunt *et al.* 1979).

In 2000, MMS contracted with Point Stephens Research to develop databases for fish, fisheries, and human use. However, this database was not created within a standardized query system and was not integrated with the seabird and marine mammal distributional data. Recently, the MMS Pacific OCS Region office identified the need to integrate all existing database layers (metadata and spatial coverages) into one comprehensive GIS-based system

that allows resource management personnel unrestricted capacity to conveniently extract any combination of environmental, species, fishery, or human use data according to specified temporal and spatial queries.

Objectives. MMS Pacific OCS Region survey and resource data are currently only available within data files and disparate databases. However, to maximize the value of these data for MMS and other management agencies, the information should be readily available for queries by resource managers making planning decisions. Thus, the purpose of this study is to integrate the USGS-HSU seabird and marine mammal dataset with the Point Stephens Research fisheries database in a comprehensive relational database linked to geographic information system coverages, with a webpage version for public access.
1. Develop a comprehensive relational database and geographic information system for seabird, marine mammals, fisheries, and human resources off southern California.
2. Complete a public webpage interface for the relational database.

Methods. The seabird and marine mammal database is summarized by density and is stored by species, season, and sub area in GIS coverages at two spatial scales: 1′ and 5′ blocks. To maximize management utility for client agencies, a relational database that allows users to query for specific values (densities, totals) and factors (species, season, sub area) is needed. Recently, USGS has worked with the California Department of Fish and Game in development of a relational database known as BIOS (Biogeographic Information and Observation System, http://bios.dfg.ca.gov/). This relational database was developed by a management agency for querying resource information; thus, it is well-suited as the model for an integrated database in the Pacific Region.

USGS is currently working on updating the MMS/USGS marine mammal and seabird database. This study proposes to integrate this information with the previously developed Point Stephens Research databases. The MMS Pacific OCS Region supported development of both databases, and the relational database design for fisheries databases will have direct linkage to the seabird and marine mammal survey database. This product will be distributed on CDROM and packaged with Arc Explorer (ESRI, Inc.) or similar GIS software. Data also will be provided to the public on a webpage.

**Revised Date:** April 5, 2007

**ENVIRONMENTAL STUDIES PROGRAM: Studies Development Plan FY 2008-2010**

**Region:** Pacific OCS Region

**Planning Area:** Southern California

**Title:** Investigation of PCB and PAH Contaminants in Archived Samples of Platform Resident Fish

**MMS Information Need(s) to be Addressed**: The fate of spent offshore platforms and pipelines off California has been a subject of considerable debate, much of which is focused on the potential importance of the fish populations at these facilities. The question of contamination and contaminant load in platform resident fish and shellfish continues to arise during discussions with both State and Federal agencies regarding the importance of platform resident populations. Given the recent mercury and PCB alarm concerning these compounds and their harm to humans when concentrated in edible fish tissue, it is timely to determine which contaminants are contained in various tissues of resident fish and shellfish at platforms. Knowledge of the quantity and extent of contaminants in fish and shellfish tissue along with the regional geospatial background is essential for fully evaluating the various options proposed for decommissioning California's offshore oil platforms.

**Cost Range:** (in thousands) $210 - $290 **Period of Performance:** FY 2008-2010

**Description:**

Background: Despite the fact that the question of contamination and body burden continues to arise during most discussions of resident fish and shellfish at platforms, very little study has been made of this subject. The most common contaminants discharged at platforms are hydrocarbons and trace metals. Given the recent mercury and PCB alarm concerning these compounds and their harm to humans when concentrated in edible fish tissue, it is timely to determine which contaminants are contained in various tissues of resident fish and shellfish at platforms. However the contaminant load must be seen against the background load in the area. The question regarding contamination in platform fish is often debated in discussions of the importance of platform resident populations. Some investigations done during the 1960's and 1970's indicate relatively high levels of zinc in tissue from fish collected at platforms. Work done in 1991 on polycyclic aromatic hydrocarbon (PAH) metabolites in fish bile indicates that fish collected near natural tar seeps, at nearby natural reefs, and at the mainland carry a gradient of PAH's. The contaminants present in platform resident fish and shellfish must be compared to that of the fish in the geospatial background to establish the relative importance of such contaminants given the overall picture of the region. In addition, comparison to the geospatial background will help to isolate the platform contribution to the contaminant load. The geospatial background has been developed by the Southern California

Coastal Water Research Project (SCCWRP). The SCCWRP data and reports are free and readily available through the Internet at http://www.sccwrp.org.

Thus, in order to reach conclusions about the environmental consequences of decommissioning platforms on local and regional fish populations, the sources of fish recruiting to those populations and the general pollution load carried by reproducing adults at platforms must be known. Such information is particularly important when the platforms harbor large numbers of resident reproducing adults and serve as nursery habitat for juvenile fishes that eventually may "spillover" or migrate to natural areas and help to replenish populations that are commercial and recreational fishery resources.

The MMS-funded study *Reproductive Ecology and Body Burden of Resident Fish Prior to Decommissioning*, NSL PC-05-02, Agreement Number 1435-01-05-CA-39315 was awarded in FY 2005. That investigation focuses on heavy metal contamination in fish tissue and will not determine poly-chlorinated biphenyls (PCB's) or PAH contamination. However, samples of tissue from all fishes collected for PC-05-02 were archived at the USGS/BRD, US National Contaminants Laboratory, Columbia Environmental Research Center (CERC), in Columbia, Missouri.

Objectives: 1) Survey and quantify the extent of PCB's and PAH's and/or metabolites in archived tissues of platform resident fish species in relation to the local and regional geospatial background quantity; 2) Compare platform resident body burdens and contamination levels of PCB's and PAH's and/or metabolites to those found in similar size and species of fish and shellfish at various locations away from platforms; 3) Relate the level of PCB's and PAH's and/or metabolite contaminants in platform species to the local and regional geospatial background quantity and variability of contaminants in fish and shellfish.

Methods: 1) Using tissue samples from *Reproductive Ecology and Body Burden of Resident Fish Prior to Decommissioning*, NSL PC-05-02, Agreement Number 1435-01-05-CA-and appropriate techniques, analyze tissue samples for PCB's and PAH's and/or metabolites. These samples are presently at the USGS/BRD Columbia Environmental Research Center, Columbia, MO. Dr. Thomas May assures us that the samples have been continually archived to insure integrity for PAH and PCB analysis, 2) Compare the PCB and PAH and/or metabolite contaminant load of platform resident species to the geospatial background of the areas off Point Conception, within the Santa Barbara Channel, and within the San Pedro Basin. The present study will use the same methodology as SCCWRP to determine PCB and PAH and/or metabolite contaminants in fish from platforms and natural areas; therefore, comparison of results from the present study to SCCWRP data are suitable.

**Revised Date:** April 5, 2007

**ENVIRONMENTAL STUDIES PROGRAM: Studies Development Plan FY 2008-2010**

**Region:** Pacific OCS Region

**Planning Area:** Southern California

**Title:** Predicting Abundance and Distribution of Seabirds and Mammals Based on Oceanographic Conditions

**MMS Information Need(s) to be addressed:** The study will allow MMS to refine marine mammal and seabird population estimates based on current oceanographic conditions which would aid in oil spill response, alternative energy project NEPA analyses, and evaluating decommissioning and other OCS projects.

**Cost Range:** (in thousands) $150-225 **Period of Performance:** FY 2008–2010

**Description:**

Background: Recent reports by the U. S. Commission on Ocean Policy and the Pew Oceans Commission have stressed the importance of using an ecosystem-based approach to manage ocean resources, as well as to support a national research and monitoring strategy. USGS/MMS monitoring work in coastal waters off southern California has focused on the extensive populations of resident breeding and non-resident migratory seabirds and marine mammals in this dynamic ecosystem. The islands provide breeding habitat for some of the largest seabird breeding colonies in California and some of the largest pinniped colonies in North America (Carter *et al.* 1992, Bonnell and Dailey 1993). Variation in the southern California Current has forced dramatic fluctuations in regional oceanographic conditions (Roemmich and McGowan 1995) that have altered zooplankton composition and fish abundance (Moser *et al.* 2000). However, very little is known about how fluctuating ocean conditions affect seabirds and marine mammals.

During 1999–2002, the U.S. Geological Survey (USGS) and Humboldt State University in cooperation with MMS (Mason *et al. 2004*) collected extensive aerial survey data for seabirds and marine mammals off southern California. Observers flew >55,000 km, counted >485,000 seabirds and >64,000 marine mammals, and identified 67 seabird and 19 marine mammal species. Results from the study suggested that distribution of many birds and mammals correspond to locations with unique variability in oceanographic structure (i.e., thermal water masses, frontal regions, ocean basins, etc.). In addition, recent studies show that oil platforms provide recruitment habitat for invertebrates and fish (Love *et al.* 1999, Love *et al.* 2000, Casselle *et al.* 2002, Soldal *et al.* 2002, Jorgensen *et al.* 2002, Lokkeborg *et al.* 2002). Upper-trophic-level predators such as seabirds may rely on prey resources affiliated with these structures (Weise *et al.* 2001, Adams and Takekawa *in review*).

Quantitative information is lacking but is needed to predict how changing ocean conditions (i.e., sea surface temperature, chlorophyll concentration) will modify the distribution and abundance of wildlife species in this region. Anthropogenic threats including climate change may greatly alter the distribution of current wildlife and fisheries resources, confounding our understanding of potential changes caused by individual projects or management actions. Thus, in this study, recent wildlife distributional datasets combined with oceanographic habitat features in stochastic analytical models will be used to predict occurrence and abundance of seabirds and marine mammals off southern California.

Objectives: Evaluate data from previous MMS/USGS marine mammal and seabird surveys in relation to with habitat data as described in satellite remote sensing and bathymetry data in order to:

1. Examine habitat relationships that can be used to predict species' distributions and refine population estimates.
2. Understand the relationship between specific oceanographic processes and features, such as upwelling, fronts, eddies, bathymetry and the distribution, abundance, and species composition of the primary marine mammal and seabird prey.

This information and modeling would be used to predict marine mammal and seabird distributions directly from oceanographic parameters and patterns.

Methods. Models will be combined with geographic information systems (GIS) to examine spatial and temporal patterns in the distribution and habitat utilization of select seabirds detected on surveys throughout the southern California Bight, 1999–2002. Specifically, the study will examine how fixed abiotic features (e.g., colony location, bathymetric features, etc.) and dynamic oceanographic parameters (e.g., SST, ocean color, fronts, Beaufort sea-state) affect seabird distribution and detection probabilities. This work builds on techniques and methods that have been developed for analyzing single species' habitat associations using aerial VHF telemetry, and at-sea habitats measured using satellite remote sensing. Probabilities in turn will be mapped and presented as continuous surfaces in a GIS

**Revised Date:** April 5, 2007

## 2.3 Profiles of Studies Proposed for the Fiscal Year 2009 NSL

**Table 2. Pacific OCS Region Studies Proposed for the Fiscal Year 2009 NSL**

| Page # | Discipline | Title |
|---|---|---|
| 33 | HE | Regional Importance of OCS Oil and Gas Platforms as Rockfish Nurseries |

AQ = Air Quality FE = Fates & Effects HE = Habitat & Ecology
IM = Information Management MM = Marine Mammals & Protected Species
PO = Physical Oceanography SS = Social Science

**ENVIRONMENTAL STUDIES PROGRAM: Studies Development Plan 2009-2011**

**Region:** Pacific OCS Region

**Planning Area:** Southern California

**Title:** Regional Importance of OCS Oil and Gas Platforms as Rockfish Nurseries

**MMS Information Need(s) to be Addressed:** Ecosystem-level understanding of the environment depends upon successful integration of biologic, geologic, and oceanographic information. This integration allows prediction of regional consequences from events occurring within a limited spatial scale. Such predictive capability is important in OCS permitting, mitigation, and decommissioning decisions. This study proposes to integrate sea-floor habitat maps, current flow patterns and field surveys to quantify the role oil/gas platform habitat may have in rebuilding stocks of over-fished species. Currently, shallow habitats of OCS oil/gas platforms host large numbers of economically important juvenile species, espe-cially rockfishes. Using biological and physical data, this study will (1) perform a stock assessment of rockfish juveniles within the Southern California Bight, and (2) describe potential connectivity pathways between juvenile and adult habitats within the Santa Barbara Channel region and San Pedro Basin, focusing on platform-natural reef links.

**Cost Range:** (in thousands): $400-$550 **Period of Performance:** FY 2009 - 2012

**Description:**

Background: To obtain an ecosystem-level understanding of the OCS, biological and physical databases must be integrated. To date, most ecological studies are restricted in scale due to limited funds and information. With the completion of region-wide oceanographic and geologic surveys, it is timely to link and expand biological surveys to match the spatial scale of these physical databases. Such integration will be important to all aspects of permitting, mitigation and decommissioning decisions of the OCS.

The majority of marine species observed at oil platforms and natural reefs do not reside in these habitats for their entire life history. Population connectivity within and among habitats varies according to the life history of each species, oceanographic patterns, and distribution of hard bottom. One consequence of a spatially complex life history is that impacts of a reefed platform may propagate across regions and habitats and affect other populations. Therefore, some understanding of connectivity processes, both physical and biological, must precede predictions regarding the environmental consequences of platform decommissioning alternatives. We now have sufficient knowledge to address these large scale questions. Shallow water habitats of platforms are of particular interest to MMS because these habitats function as nurseries to commercially important juvenile rockfishes, and because potential

decommissioning options eliminate this habitat. MMS information needs thus include establishing how the removal of such habitat will impact regional environments.

This study is one of a series of juvenile rockfish studies in the POCS. Previously, MMS funded the study *Assessing the Fate of Juvenile Rockfish at Offshore Platforms and Natural Reefs in the Santa Barbara Channel* NSL PC-04-02, which performed a longitudinal study on the fate of juvenile rockfish if platforms were not present. During FYs 2008-2011, MMS will support the study *Spatial and Seasonal Variation in the Biomass and Size Distribution of Juvenile Fishes Associated with a Petroleum Platform off the California Coast,* which will use a hydroacoustic array to collect fine-scale data on the abundance and species composition of juvenile fishes recruiting to one platform. Using the GIS, this proposed study will extrapolate this fine-scale information across the regional scale. To accomplish this, new field data has to be collected across a regional scale concurrently with the above study (recruitment in spring of 2009 and/or 2010) because of the annual natural of juvenile rockfish recruitment. The proposed study represents a critical next step in a coordinated program that extends local scale studies across the entire region of interest to OCS activities.

Objectives: The overall objective of this study is to begin to integrate region-wide oceanographic, geologic, and biologic data on the POCS so MMS has an ecosystem-level synthesis of the marine environment on which to base management decisions. The initial efforts in applying this synthesis will focus on understanding the regional importance of platform habitat as rockfish nurseries in order to predict consequences of decommissioning to EFH and managed fish species.

Methods: 1) Working closely with the USGS, the recipient will update a geographical information system (GIS) with newly available seafloor habitat, temperature, and bathymetry information; 2) Using information in the scientific literature on abundance distribution of life history stages (juvenile and adult) in relation to physical parameters, a series of "potential habitat" layers will be generated for each species of interest and incorporated into the GIS; 3) Using standard scuba protocols, a field survey that encompasses a regional scale will be conducted to assess the absolute biomass/stock of juvenile rockfishes that inhabit shallow water habitats (both natural reefs and platforms) within the Santa Barbara Channel region. The scuba survey will, for the first time on the Pacific coast, utilize a randomized, stratified, and geo-referenced survey design that allows for proper statistical inference across the region; 4) the GIS will use region-wide patterns of surface currents and potential habitat layers for two overfished species, lingcod and bocaccio, that have pelagic larvae which reside in the upper water column, and generate "connectivity envelopes" across areas of interest (Santa Barbara Channel region and San Pedro Basin) that outline likely pathways of larval transport, and potential juvenile-adult migration patterns. Connectivity envelopes for adult-pelagic larvae stages are constructed using larval duration periods combined with seasonal current vectors and overlaid onto potential habitat layers. Possible juvenile-adult migration patterns will be identified by potential habitat layers of each stage and distance to nearest habitat patches. In both types of analyses, platform-natural reef links will be featured.

**Revised Date:** April 5, 2007

# SECTION 3.0 TOPICAL AREAS FOR YEARS 2010

Renewable Energy and Alternate Use

Offshore wind and wave energy may be considered in the future to supplement dwindling oil and gas supplies and provide a renewable energy source. Studies will be needed to consider technical requirements offshore California, identify suitable areas and conditions, and examine regional environmental effects. Possible needs include a Northwest based CMI, workshops, and bird surveys.

Habitat Value of Platforms and Rigs to Reefs

Currently, energy companies are obligated to remove the platforms as well as the shell mounds that have developed around Pacific OCS platforms; however, there is considerable interest from the State of California and some user groups to allow some of each platform to remain in place because of their value as habitat to overfished rockfish species. Based on MMS scientific study to date the State of California is considering legislation to allow such a program on a case-by-case basis. The MMS position and decision-making on this issue should continue to be supported by further scientific study into the habitat value and importance of platforms on a regional scale.

Assessment of Cut-off Options for Rigs to Reefs

In understanding the range of alternatives, MMS needs to understand the impacts to the biology and overall habitat value from cutting the platform off at different depths below the seafloor. This issue is raised at any meeting or conference as an information need by MMS, scientists and the state.

Contribution to Stock

Once studies have been completed which describe the fish assemblages around OCS platforms and pipelines, estimates of their contribution to fish stock will need to be made in order to assess the impact of decommissioning.

Habitat Mapping

A few data gaps exist in the Santa Barbara Channel in water depths less than 100 m both in the Eastern Channel and west of Santa Barbara. Data from these areas will assist us in decisions about aging pipeline routes as changes are needed in these lines. The data will also be used to continue to map seafloor seeps.

# SECTION 4.0 LITERATURE CITED

**Literature Cited:**


Adams, J., and J. Y. Takekawa. *In review*. At-sea distribution of radio-marked Ashy Storm-Petrel (*Oceanodroma homochroa*) captured in the California Channel Islands. Marine Ornithology.

Airame, S.; J.E. Dugan, K.D.Lafferty, H.Leslie, D.A. McArdle and R.R. Wamer. 2003. Applying ecological criteria to marine reserve design: a case study from the California Channel Islands. Ecological Applications. 13(1), pp 170-184.

Bonnell, M.L., and M.D. Dailey. 1993. Marine Mammals. Pp 604-681 *in*: M.D. Dailey, D.J. Reish, and J.W. Anderson (eds.), Ecology of the Southern California Bight: A Synthesis and Interpretation. Berkeley/Los Angeles: University of California Press.

Carter, H.R., G.J. McChesney, D.L. Jaques, C.S. Strong, M.W. Parker, J.E. Takekawa, D.L. Jory, and D.L. Whitworth. 1992. Breeding populations of seabirds in California, 1989-1991. U.S. Fish and Wildlife Service, Northern Prairie Wildlife Research Center, Dixon, California, and San Francisco Bay National Wildlife Refuge Complex, Newark, California. Draft final report to Minerals Management Service, Pacific OCS Region, under Inter-agency Agreement No. 14-12-001-30456. Volumes I and II.

Casselle, J.E., M.S. Love, C. Fusaro, and D. Schroeder. 2002. Trash or habitat? Fish assemblages on offshore oilfield seafloor debris in the Santa Barbara Channel, California. ICES J. Mar. Sci. 59, Suppl. S:258-265.

Clarke, E. D., Spear, L. B., McCracken, M. L., Marques, F. C., Borchers, D. L., Buckland, S. T., and Ainley, D. G. 2003. Validating the use of generalized additive models and at-sea surveys to estimate size and temporal trends of seabird populations. J. Appl. Ecol. 40:278–292.

Hastie, T., and Tibshirani R. 1990. Generalized additive models. Chapman & Hall, London.

Jorgensen, T., S. Lokkeborg, and A.V. Soldal. 2002. Residence of fish in the vicinity of a decommissioned oil platform in the North Sea. ICES J. Mar. Sci. 59, Suppl. S:288–293.

Lokkeborg, S., O.B. Humborstad, T. Jorgensen, and A.V Soldal. 2002. Spatio-temporal variations in gillnet catch rates in the vicinity of North Sea oil platforms. ICES J. Mar. Sci. 59, Suppl. S:294-299.

Love, M.S., J.E. Casselle, and L. Snook. 1999. Fish assemblages on mussel mounds surrounding seven oil platforms in the Santa Barbara Channel and Santa Maria Basin. Bull. Mar. Sci. 65(2):497-513.

Love, M.S., J.E. Casselle, and L. Snook. 2000. Fish assemblages around seven oil platforms in the Santa Barbara Channel area. Fish. Bull. 98(1):96–117.

Mason, J. W., Gerard J. McChesney, W. R. McIver, H. R. Carter, J. Y. Takekawa, R. T. Golightly, J. T. Ackerman, D. L. Orthmeyer, W. M. Perry, J. L. Yee, M. O. Pierson, and M. D. McCrary. 2004. Distribution and abundance of seabirds off Southern California. In: Takekawa, J. Y., H. R. Carter, J. T. Ackerman, J. Adams, J. W. Mason, G. J. McChesney, W. R. McIver, R. T. Golightly, D. L. Orthmeyer, M. O. Pierson, and C. Hamilton. 2004. At-Sea Distribution and Density of Seabirds and Marine Mammals in the Southern California Bight: 1999–2002, Summary Report. Unpublished Report, U. S. Geological Survey, Western Ecological Research Center, Vallejo, CA; and Humboldt State University, Department of Wildlife, Arcata, CA.

Moser, H.G., R.L. Charter, W. Watson, D.A. Ambrose, J.L. Butler, S.R. Charter, and E.M. Sandknop. 2000. Abundance and distribution of rockfish (*Sebastes*) larvae in the Southern California Bight in relation to environmental conditions and fishery exploitation. CALCOFI Reports 41:132-147.

Roemmich, D., and J. McGowan. 1995. Climatic warming and the decline of zooplankton in the California Current. Science 267: 324-1326.

Soldal, A.V., I. Svellingen, T. Jorgensen, and S. Lokkeborg. 2002. Rigs-to-reefs in the North Sea: Hydroacoustic quantification of fish in the vicinity of a “semi-cold” platform. ICES J. Mar. Sci. 59, Suppl. S:281-287.

Swartzman G., Huang C., Kaluzny S. 1992. Spatial analysis of Bering Sea groundfish survey data using generalized additive models. Can J Fish Aquat Sci 49:1366–1378.

Weise, F.K., W.A. Montevecchi, G.K. Davoren, F. Huettmann, A.W. Diamond, and J. Linke. 2001. Seabirds at risk around offshore oil platforms in the North-west Atlantic. Mar. Poll. Bull. 42(12):1285-1290.