University of California

Coastal Marine Institute

Annual Report

2002 - 2003

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Russell J. Schmitt
Program Manager, CMI
and
Director, Coastal Research Center

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

Mission of the Coastal Research Center

The Coastal Research Center of the Marine Science Institute, UC Santa Barbara, facilitates research and research training that foster a greater understanding of the causes and consequences of dynamics within and among coastal marine ecosystems. An explicit focus involves the application of innovative but basic research to help resolve coastal environmental issues.

Disclaimer

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THE COASTAL MARINE INSTITUTE

A Cooperative Program involving the

University of California, the State of California

and the

Minerals Management Service US Department of Interior

ANNUAL REPORT

PROGRAM YEAR 9

July 15, 2003

PROGRAM MANAGER'S REPORT

The Coastal Marine Institute (CMI) was initiated in July 1994 as a cooperative research and research training program involving the Minerals Management Service, the State of California and the University of California. The focus is on long-term environmental, social and economic consequences of oil and gas production activities in the Pacific Outer Continental Shelf region. This Annual Report summarizes activities and research progress during Program Year 9 (July 1, 2002 - June 30, 2003).

Major programmatic progress achieved during Program Year 9 of the CMI:

- During 2002 – 2003, 33 regular and research faculty, 100 trainees (1 postdoctoral, 19 graduates, 39 undergraduates, and 41 staff) from 6 campuses and laboratories participated in CMI research projects;
- This Program year, CMI-sponsored studies published 11 peer-reviewed papers, with an additional 39 research presentations. In addition, 6 CMI-MMS final reports were completed and 3 draft final reports are currently in review.

SUMMARY OF RESEARCH PROGRESS

Task No. 12387: *Consequences of Alternative Decommissioning Options to Reef Fish Assemblages and Implications for Decommissioning Policy* (Study: *Ecological Consequences of Alternative Abandonment Strategies for POCS Offshore Facilities and Implications for Policy Development*)

Principal Investigators: Mark H. Carr, Department of Biology, University of California, Santa Cruz, CA 95064 **Michael V. McGinnis,** Coastal Research Center and Ocean and Coastal Policy Center, Marine Science Institute, University of California, Santa Barbara, CA 93106-6150 and **Graham E. Forrester,** Department of Natural Resources Science, Coastal Institute in Kingston, University of Rhode Island, Kingston, RI 02881

Project Objectives

Critical to formulation of appropriate decommissioning policy is an understanding of the ecological, economic and social consequences of different decommissioning options and identification of the mechanisms by which such information is incorporated, or not, into legislation and public policy. Perhaps the most important ecological consequence of abandoning POCS facilities is a potential change in regional fish production (the biomass of fish accrued per year), which may in turn influence yields to fisheries. Hard substratum reefs represent a small fraction of the available offshore habitat in California, but are sites of high fish production. However, prior to this study, only one study provided quantitative estimates of species composition and abundance of fishes at a single platform off southern California.

Objective 1: Ascertaining the ecological and related economic effects of total or partial removal of offshore structures

A. Quantitative description of fish assemblages on natural reefs and offshore structures.

One objective of this study has been to quantify the species and sizes of fishes associated with platforms and natural reefs. Such information is required to determine what species and life stages might be influenced by the various decommissioning options. Do fish recruit to each habitat type from the plankton (as larvae) or migrate on to one habitat type from the other as older stages (benthic juveniles and adults)? Comparison of fishes between platforms and natural reefs provides information on what stages use the two habitat types. Patterns of fish sizes over time can also provide information on how long fishes associate with each habitat type and how well they grow and survive. Such information is critical to understanding the relative value of natural reefs and platforms as fish habitat.

B. Estimates of transfer of fish production between offshore structures and other habitats.

Fundamental to understanding the net contribution of local populations to regional production is information on the size-specific rate of migration of fishes among local, reef-associated populations. In the context of platform decommissioning, knowledge of the net direction and rate of transfer of biomass between platforms and natural reefs is crucial. For example if fish recruit to natural reefs and eventually migrate to platforms, accumulation of fish biomass on platforms would be incorrectly attributed to production at the platform habitat. Conversely, if platforms provide recruitment habitat for fish that eventually migrate to natural reefs, the contribution of platforms to regional production may be grossly underestimated by simply

measuring production in the two habitats. Movement information is also important to determine whether the loss of fish at a site is due to emigration rather than mortality. Therefore, we have conducted a tagging study determine how much and what direction (from platforms to reefs or vice versa) fish move, the rate of that movement, and net direction of exchange.

Objective 2: Examining whether and how scientific information has influenced prior abandonment policy

The southern and central regions of California are rapidly entering a new era of OCS oil and gas activity. Decommissioning of offshore oil and gas facilities is rapidly becoming an issue of concern. The ultimate cultural and ecological impacts of decommissioning OCS oil and gas structures is not well understood by scientists, policy makers or the general public. Scholars have examined the political dimensions of oil and gas leasing, exploration and production associated with the Outer Continental Shelf (OCS). Researchers have uncovered critical differences between OCS oil and gas regions; the politics of OCS oil and gas development is based on important local, regional, legal, technological, and socio-economic considerations. These considerations are unlikely to be generalizable across regions, places or locations. In other words, OCS oil and gas development is contingent upon sociocultural factors that are endemic to particular places, regions and localities and not just the presence of OCS oil and gas reserves, government's willingness to create opportunities for the development of oil and gas, or the availability of modern technologies to develop oil and gas. Similarly, development of decommissioning policy, including the role of scientific information as a basis for such policy, is likely to be more or less important among OCS regions, depending on socio-economic considerations.

Summary of Research

Progress during 2002-2003

Analysis and writing culminated in the DRAFT final report, which was submitted to the Coastal Research center on May 30, 2003. The DRAFT final report was submitted to MMS for comments before being finalized.

Task No. 12388 *&* **Task No. 17610:** *Joint UCSB-MMS Pacific OCS Student Internship and Trainee Program*

Principal Investigators: Jenifer Dugan, Marine Science Institute, University of California, Santa Barbara, CA 93106-6150 and **Edward Keller**, Environmental Studies and Geological Sciences Departments, University of California, Santa Barbara, CA 93106-9630

Summary of Research

Progress during 2002-2003

The CMI internship program experienced substantial growth and continued success this year with excellent interest and participation by prospective interns and mentors. Feedback from all participating interns and mentors has been positive and enthusiastic. The UC Santa Barbara Environmental Studies Internship Program continued to serve as an effective mechanism for advertising positions, screening applicants and reviewing intern performances. Our expanded distribution of advertisements for intern positions to other academic departments at UC Santa Barbara including: Department of Ecology, Evolution and Marine Biology, Department of Geology, Department of Geography, Girvetz Graduate School of Education and the Donald Bren School of Environmental Science and Management continued to assist with locating prospective interns this year and was successful in reaching students from a range of academic majors, levels and backgrounds to fill internship openings.

Over the past year, 13 graduate and undergraduate students participated as interns in 10 research projects. We worked with MMS personnel to develop position descriptions and advertise several new internships through UCSB academic departments and programs. Student interns were jointly mentored by MMS staff and/or a member of the UCSB faculty or professional research staff. During the Summer of 2002 and the 2002-2003 academic year, CMI interns were involved in a variety of projects at MMS including: i) supporting the MMS marine archeology program by digitizing maps, organizing and archiving archaeological information into an existing database, and creating narratives and website information on archaeological resources from the region (Jason Chau and Mike Williams mentored by Dr. Jim Lima and Fred Piltz of MMS), ii) assisting with a regional database for use in site-specific geological and engineering evaluation of producing offshore fields in the Santa Maria Basin, Santa Barbara Channel and offshore Long Beach (Tim Wolff and Rusty Roland mentored by Ms. Joan Barminski, Mr. Mayerson and Mr. Mike Brickey of MMS), iii) rebagging, organizing and archiving geologic samples from well sites for long term storage (Joe Moulton mentored by Mr. Scott Drewry of MMS), iv) developing educational curricula at the Santa Barbara Maritime Museum (Ms. Catrina Mangiardi mentored by Drs. Jim Lima and Fred Piltz of MMS, Summer '02) and v) assisting with the development of marine education curriculum and classroom kits (Kelly Campbell and Jennifer Klaib mentored by Ms. Dunaway of MMS).

In the Fall of 2002, we applied for and secured new funding from the UCSB Shoreline Preservation Fund to expand our internship program and support additional undergraduate interns in the CMI program for Winter and Spring 2003. This funding is being used to support 5 new undergraduate student interns who are assisting CMI Principal Investigators with CMI research projects, including Tim Malone who is assisting with fieldwork in the CMI microdrifter

research project mentored by Dr Ohlmann of UCSB, Jessica Bean who is assisting with genetic analyses of bryozoans from offshore oil platforms and reefs mentored by Dr. Hodges of UCSB, Frank Kinnaman is assisting with the development of a gas chromatography system for the analysis of aromatic hydrocarbons in natural petroleum samples mentored by Dr. Valentine of UCSB, Daniel Day is assisting with investigations of natural products from bryozoans on offshore oil platforms mentored by Dr. Jacobs of UCSB, and Sabrina **xx?** is assisting with laboratory sample analyses to compare benthic invertebrates from offshore oil platforms and natural reefs mentored by Drs. Page and Dugan of UCSB.

Joint UCSB-MMS Pacific OCS Graduate Trainee Program

Graduate students and post-doctoral researchers continued to be directly or indirectly exposed to research sponsored by the Coastal Marine Institute through a variety of mechanisms. This exposure ranged from short term participation in field studies to the development of thesis proposals related to CMI projects. Students involved in short-term participation in CMI projects received summaries of the objectives and the relevance of the studies to decision-making and policy development at MMS. In addition, some of the information produced by CMI sponsored projects has been incorporated into graduate and undergraduate curricula at UC Santa Barbara. A list of participating graduate students and postdoctoral researchers appears in a separate section of this Annual Report.

Information Transfer Seminars (ITS)

No information transfer seminars were presented during this reporting period.

Task No. 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 93106-9610 and **Andrew J. Brooks,** Coastal Research Center, Marine Science Institute, University of California, Santa Barbara, CA 93106-6150

Summary of Research

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.

The behavior of the California Current System plays a critical role in determining the conditions of the nearshore marine environment off Southern California. The typically high productivity of this system is attributed to coastal upwelling which brings deeper, nutrient-rich water to the surface near shore. This high supply rate of nutrients enhances primary productivity, which in turn increases secondary productivity of the nearshore pelagic and benthic food webs. Time series studies of the California Current System conducted by the California Cooperative Fisheries Oceanic Investigations since the 1940's have revealed distinct seasonality within a year, and periodic wholesale change during El Niño Southern Oscillation (ENSO) events that have relatively brief (1-2 years) durations. There is abundant evidence that the California Current System has undergone a longer, interdecadal length change since the late 1970's and early 1980's. One manifestation off Southern California of this apparent regime shift was a rapid, large, and persistent increase in seawater temperature. Between 1976-1977, mean annual surface temperatures in the Southern California Bight rose an average of $1^{o}C$ or more above the mean for the previous two decades. Associated with this warming event were a number of changes in other physical processes and events that can influence marine biota. Among the more important manifestations in Southern California of these altered physical conditions was a decrease in productivity in surface waters near shore. Although the exact physical explanation is still under study, it appears reasonably certain that the amount of nutrients upwelled into surface waters has declined during this recent period of elevated seawater temperature. There is compelling evidence that the abundances of many coastal species off Southern California have undergone dramatic declines over the past 1-2 decades in response to falling productivity in near shore, surface waters.

The vast amount of long-term data on nearshore biota collected by a large number of separate monitoring programs in the Southern California OCS region represents a relatively untapped "gold mine" of information for environmental managers. The occurrence of a regime shift in the ocean climate in the North Pacific in the past two decades provides a unique opportunity to

determine whether and how various components of the biota respond to this source of perturbation. Data from long-term monitoring programs not only indicate the current state and recent history of the biota, they can revel much about the ecological structure of various coastal ecosystems, including the dynamical behavior and regulation of different food webs. Such knowledge provides managers with better understanding and enhanced predictive ability regarding the potential impacts to these ecosystems from other potential sources of disturbance. Further, analyses of existing data sets can expose whether and how our ability to estimate or interpret responses of the biota may be constrained by present monitoring practices.

Progress during 2002-2003

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.

We initially analyzed 8 separate datasets enumerating the flora and fauna of nearshore marine communities 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. Data were standardized between studies by re-expressing data on population densities as the percent change in initial population density over the time period 1977-2000. Organisms within a given community were assigned to one of four trophic categories, primary producer, primary, secondary, or tertiary consumer, based on published life history information. 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. Next, we performed various time-series analyses on these data sets to describe temporal trends and explore the timing and magnitude of the observed changes. 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, again 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. Most recently, we have analyzed data collected by the National Marine Fisheries Services during their triennial surveys of west coast groundfishes. This dataset covers the same time period as the earlier datasets that we analyzed, 1977-2001, but concentrates on fish species inhabiting the deeper waters of the continental shelf (55-500m). In addition, these surveys are conducted along the west coast of the United States from Monterey Bay, California to Alaska giving us a much broader geographic coverage. While many species present in this dataset (most notably several species of rockfishes) exhibited declines consistent with those observed in our other datasets, certain species (most notably flatfishes) actually increased in abundance during the period 1977-2001. Categorizing species as to trophic level, reproductive mode, or geographic region did not alter these results. We are analyzing this dataset further using length frequency distributions in

an attempt to determine if observed increases occurred before, during, or after periods of declines seen in other species.

We continue to collaborate with John Stephens Jr. and Dan Pondella of the Vantuna Research Group and Kevin Herbinson of SCE in order to update all of our databases through 2001 and to include data on fish larval abundances from 1977 through 2001. We plan to use these data to test hypotheses concerning "top down" versus "bottom up" flow of trophic cascades.

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

We have finished the process of identifying epifaunal invertebrate samples collected during our 2001 surveys. We also have continued with our 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. Sampling of fish (via visual counts along permanent band transects) and algal cover (via random point contact methods) were accomplished in the manner described in our proposal. Epifaunal invertebrates collected from all of these sites have been rough sorted and preserved for later taxonomic identification. We have begun to observe increases in the numbers of young-of-the-year surfperches at many of our sites. These increases are coincident with the return of cooler waters to the Southern California Bight.

Publications and Presentations

Brooks participated in a symposium held during the recent Southern Academy of Sciences Meetings in May, 2003. We have one publication in the Journal of Marine and Freshwater Research [Brooks, A.J., R. J. Schmitt and S. J. Holbrook. 2002. Declines in regional fish populations: have different species responded similarly to environmental change? Marine and Freshwater Research 53(2):189-198.], and we are currently preparing two additional papers for publication. The first of these will be submitted to the Journal Ecology Letters in June, 2003. The second will be submitted to the Journal Ecological Applications in the fall of 2003.

Task No. 15118: *An Experimental Evaluation for Methods of Surfgrass (Phyllospadix torreyi) Restoration Using Early Life History Stages*

Principal Investigators: Daniel C. Reed, Marine Science Institute, University of California, Santa Barbara, CA 93106-6150 and **Sally J. Holbrook**, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, CA 93106-9610

Summary of Research

Our research addresses the important issue of mitigation of adverse effects of OCS (Outer Continental Shelf) oil and gas related activities on surfgrass (*Phyllospadix* spp.) communities. *Phyllospadix* is an important structure-forming plant in the intertidal and shallow subtidal zones that is impacted by a number of activities associated with offshore oil and gas production. With funding from Santa Barbara County and the MMS - UC Coastal Marine Institute Program, we gathered much needed information on the reproductive ecology of *Phyllospadix* and we identified the most appropriate life stages of surfgrass for use in restoration. The primary objectives of our current MMS - UC Coastal Marine Institute funded research are to: (1) test the feasibility of various techniques of outplanting laboratory reared seedlings to the field and evaluate their usefulness in restoring damaged surfgrass populations, (2) collect information on the growth and survivorship of naturally recruited surfgrass seedlings for use in estimating the time required for restored populations to fully recover, (3) test the feasibility of transplanting plugs of adult plants as a viable means of restoration and to compare their performance (growth and survivorship) to that of laboratory-reared seedlings outplanted to the field.

Progress during 2002-2003

Analyses and writing culminated in the DRAFT Final report, which was submitted to MMS in March 2003 for comments. The Final report was submitted June 3, 2003.

Task No. 17601: *Habitat Value of Shell Mounds to Ecologically and Commercially Important Benthic Species*

Principal Investigators: Mark Page, Marine Science Institute, University of California, Santa Barbara, CA 93106-6150 **Jenifer Dugan**, Coastal Research Center, Marine Science Institute, University of California, Santa Barbara, CA 93106-6150 and **James Childress,** Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, CA 93106-9610
Graduate Student: Rachel E. Bomkamp

Summary of Research

Shell mounds form over time under offshore oil platforms as encrusting invertebrates, chiefly mussels, barnacles, and scallops, fall from platform support surfaces and accumulate on the seafloor. These mounds provide habitat for a diverse invertebrate community that depends on the food subsidy provided by faunal litterfall from the overlying structure for nourishment. When platforms are decommissioned and removed, the shell mounds remain, but faunal litterfall is no longer available as a food source for the shell mound community. The fate of shell mounds following platform decommissioning and removal is controversial because their habitat value is unknown. To assess habitat value of these mounds relative to shell mounds with existing platforms, we are comparing the distribution and abundance and population size structure of commercially important crab species (*Cancer antennarius*, *C. anthonyi*, *C. productus*, and *Loxorhynchus grandis*) and other invertebrate and fish taxa. In addition, we are assessing the body weight of the chestnut cowry (*Cypraea spadicea*) at shell mounds with and without existing platforms.

Using shell mounds under existing platforms "Hogan," "Houchin" (Pacific Operators Offshore), and "Gina" (Nuevo Energy Company), and shell mounds at the sites of four decommissioned platforms "Hazel", "Hilda", "Heidi", and "Hope" we are: (1) quantifying the distribution and abundance of ecologically and commercially important benthic organisms on the shell mounds, (2) determining the population size structure of the most abundant taxa at each site, and (3) using the nutritional condition of organisms to evaluate the habitat value of shell mounds. The results of our research will potentially contribute to decisions regarding the fate of shell mounds following platform decommissioning.

We investigated the distribution and abundance of benthic invertebrates using two techniques. For commercially important crabs, baited commercial crab traps were deployed at each soft bottom, shell mound, and platform location (excluding platform Gina). Traps were lowered to the bottom at each sampling location and retrieved after a 24-hour soak time. Captured crabs were counted, sex was determined, and carapace length (for majid crabs) or carapace width (for cancrid crabs) was measured. Sampling was repeated once a month for 4 months beginning in September in 2000 and August 2001. Second, we used band transects to estimate the abundance of invertebrate taxa other than crabs on the two shallow shell mounds (Hazel and Hilda) and on the shell mound at platform Gina. Divers attached transect lines to a central point (the buoy chain at the shallow shell mounds and a conductor pipe on platform Gina), and extended the lines out in a radial fashion; the result was a "wheel spoke" sampling regime. The divers then swam the length of the transects and collected selected benthic macroinvertebrate taxa in a one meter swath. In order to correct for potential over sampling of the area closest to the central point

inherent in this sampling design, the transects were divided into 4 segments. For analysis, data are weighted with regard to distance from the central point, e.g. the segments closest to the central point are weighted less than those farther away. We also compared the body weight of the chestnut cowry, *Cypraea spadicea,* among shallow shell mounds (Gina, Hazel, and Hilda). Dry body weight was regressed against shell length for each location. Divers collected animals of a range of sizes from the shell mounds such that the size distributions overlapped among locations. Collected individuals were measured, soft tissue excised, and oven dried at 90° C to a constant weight.

Progress during 2002-2003

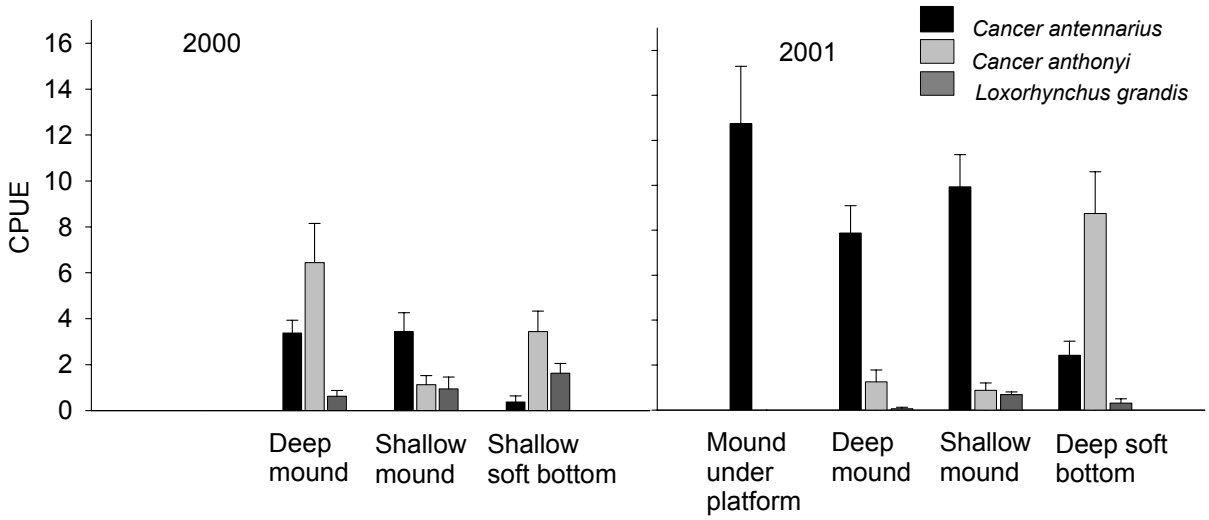


Figure 1. Relative abundances of *Cancer antennarius*, *C. anthonyi*, and *Loxorhynchus grandis* (as CPUE) in 2000 trapped on deep and shallow shell mounds (n=7 at each) and shallow soft bottom (n=8 deployments), and in 2001 trapped on mounds under platforms (n=7 deployments), deep and shallow shell mounds (n=8 deployments at each), and deep soft bottom (n=8 deployments) (x ± 1SE).

Crab densities varied among species and among habitat types in 2000 and 2001 (Fig 1). In 2000, *Cancer antennarius* was more abundant at the shell mounds without platforms (~3 individuals/trap at both deep and shallow mounds) than at shallow soft bottom (less than 1 individual/trap). *C. anthonyi* was most abundant on deep mounds (6-7 individuals/trap), followed by shallow soft bottom (3 individuals/trap) and shallow mound sites (1 individual/trap). *Loxorhynchus grandis* were more abundant on shallow soft bottom (2 individuals/trap) than at mounds (less than one individual/trap at both deep and shallow mounds). Catch of *C. productus* was negligible during the 2000 sampling period – only four individuals were caught in our traps.

In 2001, traps were also deployed at shell mounds beneath existing platforms (Hogan and Houchin), and at deep instead of shallow soft bottom sites. *Cancer antennarius* were most abundant at the mounds under platforms (13 individuals/trap), with slightly lower abundances at deep and shallow shell mounds (8-10 individuals/trap), and significantly less at deep soft bottom (3 individuals/trap). In contrast, *C. anthonyi* were much more abundant on deep soft bottom (8 individuals/trap) than on deep or shallow shell mounds (~1 individual/trap), and none were

captured on shell mounds beneath existing platforms. Few *Loxorhynchus grandis* were captured at deep soft bottom and shell mound sites (<1 individual/trap), and none were found on shell mounds beneath existing platforms. No *C. productus* were captured during the 2001 sampling period.

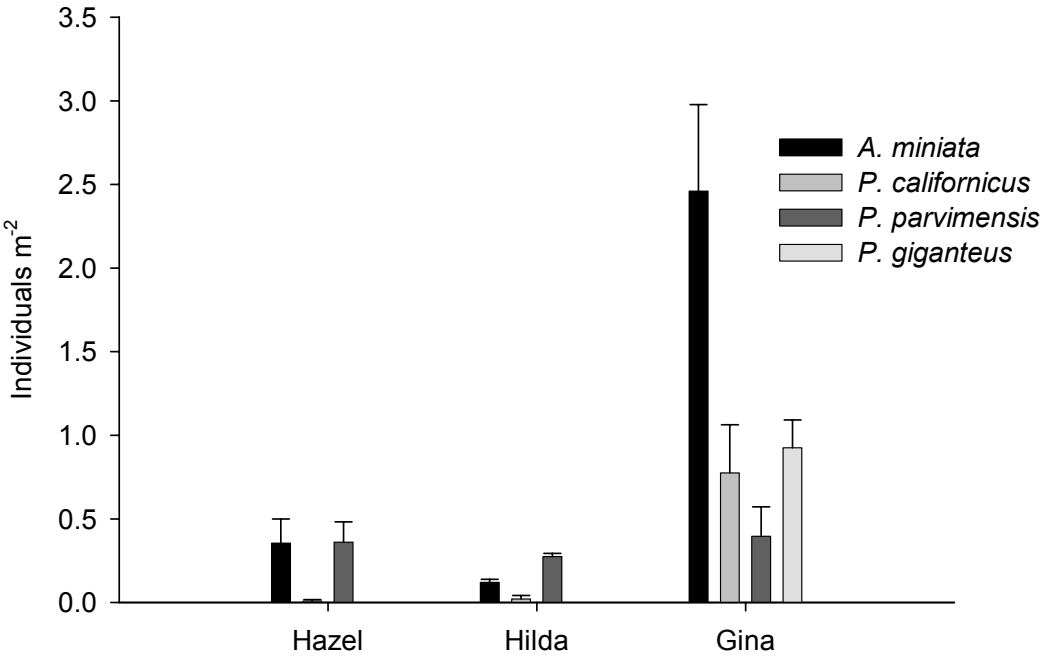


Figure 2. Mean relative abundances of *Asterina miniata, Parastichopus californicus*, *Parastichopus parvimensis*, and *Pisaster giganteus* (as individuals m^{-2}) at Hazel mound (n=4 transects), Hilda mound (n=3 transects), and the mound under Platform Gina (n=3 transects) (x ± 1SE).

Estimated densities of invertebrates at the shell mounds without platforms, Hazel and Hilda, were generally lower than those observed on the mound under Platform Gina (Fig 2). Densities of *Asterina miniata* were lowest at Hilda mound (0.12 ± 0.02 individuals m^{-2}), slightly higher at Hazel mound (0.34 ± 0.14 individuals m^{-2}), and greatest at the mound under Platform Gina (2.54 ± 0.53 individuals m^{-2}). Densities of *Parastichopus californicus* followed the same general pattern: 0.02 ± 0.02 individuals m^{-2} on Hilda mound, 0.05 ± 0.05 individuals m^{-2} on Hazel mound, and 0.74± 0.30 individuals m^{-2} on the mound under Platform Gina. The trend of higher densities at mounds with overlying platform structure was also observed for *P. parvimensis*, with greater abundances observed on the mound under platform Gina (0.45 ± 0.13 individuals m^{-2}) than on Hilda mound (0.28 ± 0.14 individuals m^{-2}) and Hazel mound (0.25 ± 0.14 individuals m^{-2}). The predatory seastar *Pisaster giganteus* was observed only on the mound under platform Gina at a density of 0.89 ± 0.17 individuals m^{-2}.

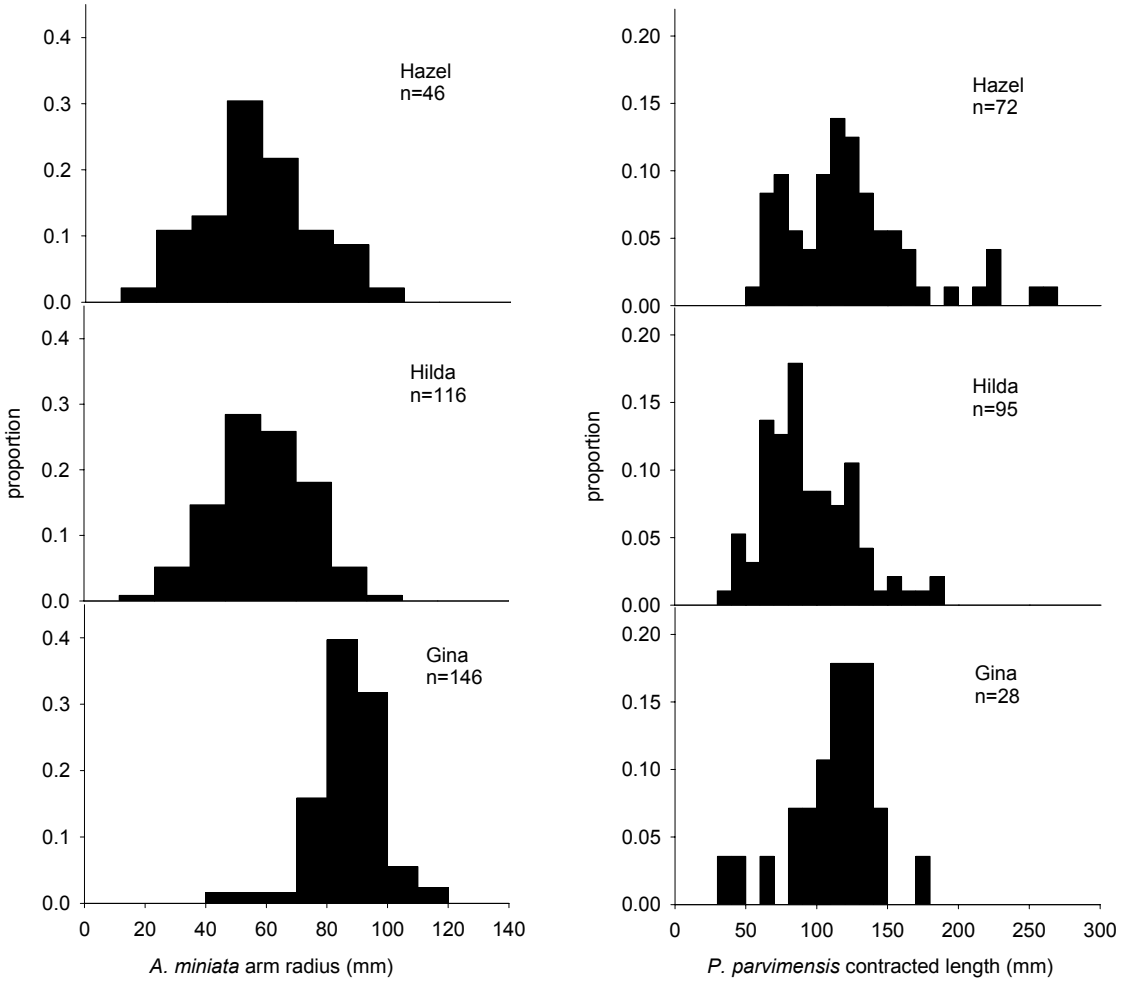


Figure 3. Size frequency distribution of *A. miniata* and *P. parvimensis* at mounds at Hazel, Hilda, and under Platform Gina.

Our results suggest that benthic invertebrates, including a number of echinoderm species, are generally larger on mounds under existing platforms than on mounds without platforms (Fig. 3). *Asterina miniata* were significantly larger on the mound under Platform Gina (87 ± 1 mm mean arm radius, n=126), than on Hazel mound (48 ± 2 mm mean arm radius, n=46) and Hilda mound (51 ± 1 mm mean arm radius, n=116)($p = 0.000$, $F = 244.13$, df = 2, 1-way ANOVA). The same trend was evident for other invertebrate taxa. The mean contracted length of *Parastichopus californicus* was smaller on Hilda mound (114 ± 7 mm, n=8) than on the mound under Platform Gina (162 ± 6 mm, n=46) ($p = 0.002$, $F = 10.63$, df = 1, 1-way ANOVA). *Pisaster giganteus* were almost twice as big on the mound under Platform Gina (336 ± 6 mm mean arm radius, n=40) than on Hilda mound (181 ± 7 mm mean arm radius, n=2). For *P. parvimensis*, size varied significantly among sites, but did not follow the pattern seen in other species ($p < 0.001$, $F = 13.49$, df = 2, 1-way ANOVA). Overall, individuals of this species appeared to reach slightly larger sizes at the Hazel mound (123 ± 5 mm mean contracted length, n=72) than at the mound under Platform Gina (110 ± 5 mm contracted length, n=28) and were smallest at the Hilda.

mound (93 mm ± 3 mm mean contracted length, n=95). Post-hoc tests showed that the mean contracted length of this species was significantly larger at the Hazel mound than at Hilda mound but the sizes of the individuals on Gina did not differ significantly from the other two sites (post-hoc Tukey test).

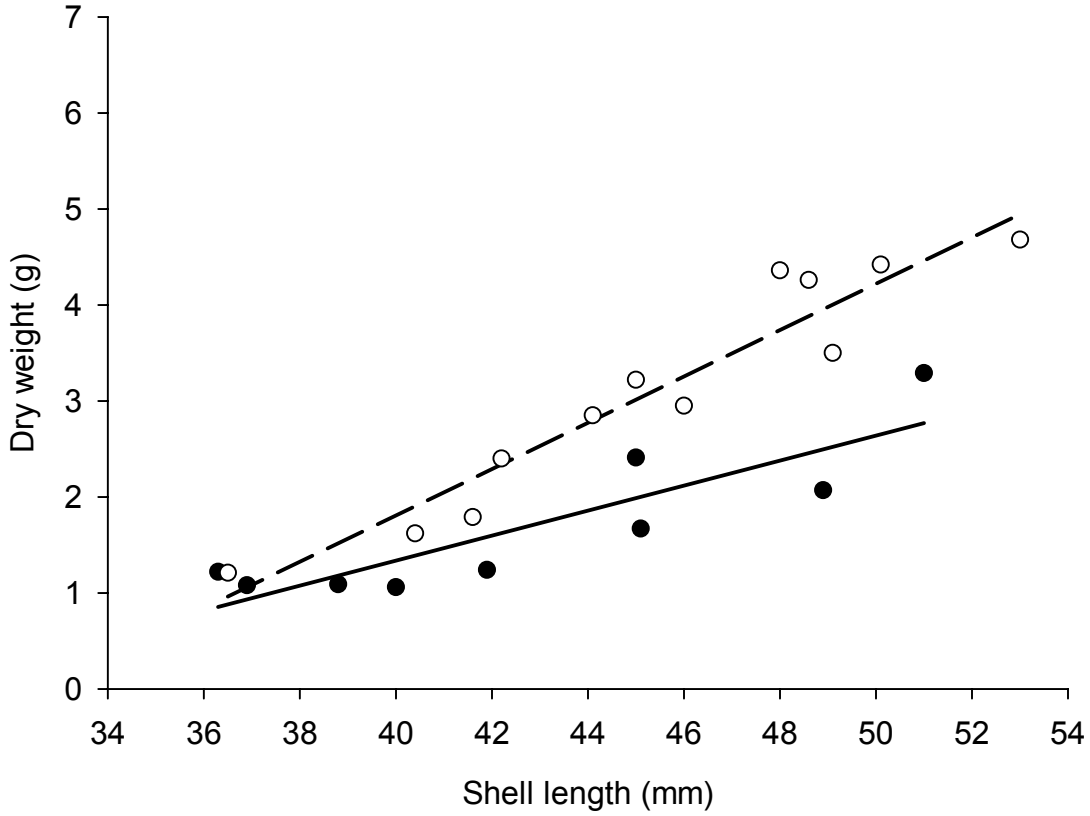


Figure 4. Body dry weight versus linear measure of size for *Cypraea spadicea* collected at shallow mound only (n=9, r^2=0.77, y=0.13x-3.88) and shallow mound + platform (n=12, r^2=0.91, y=0.24x-7.846).

For the cowry, *Cypraea spadicea*, the relationship between dry body weight and shell length differed significantly among locations. The slope of the regression of tissue dry weight on shell length was significantly greater for individuals from the mound under Platform Gina than for shell mounds Hazel and Hilda. (*t*-test of homogeneity of slopes; Fig. 4). These length-specific biomass data suggest better condition and more lipid storage and/or gonadal development in the presence of faunal litterfall.

Preparation of a Masters Thesis and manuscript for publication is nearly complete.

Task No. 17602: *Inventory of Rocky Intertidal Resources in Southern Santa Barbara, Ventura and Los Angeles Counties*

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

Summary of Research

Progress during 2002-2003

The seven long term monitoring sites included in this report include five sites in Los Angeles County (Paradise Cove, White's Point, Point Fermin, Bird Rock and Little Harbor), and two in Ventura County (Old Stairs and Mussel Shoals). Two of these sites, Bird Rock and Little Harbor, continue to be sampled by Jack Engle (UC Santa Barbara) during Channel Islands Research Program cruises to the island. While the minimum set of photoplot photographs are taken during these visits, the full sampling effort including photosurveys and motile invertebrate data collection has not been completed for several years. The Catalina photoplot slides are sent to southern Santa Barbara County sites (Alegria, Arroyo Hondo, Coal Oil Point and Carpinteria). Pete Raimondi's group at UC Santa Cruz is responsible for the Inventory Program's four northern Santa Barbara and San Luis Obispo County sites. Under the current arrangement, the UCLA group collects and enters the data for the southern Santa Barbara sites, then the data files are sent to the UCSC group for data analysis and report preparation.

This year marks the third report period for which the inventory of Los Angeles County rocky intertidal monitoring program was supported by MMS funding, and the fifth period for Ventura County. The primary staff researcher responsible for managing and executing this project is Steven Lee, now in his fifth year on the project. Sean Bergquist has provided assistance for the last three years but has recently left the project. One other technician, Meera Venkatesan, also assisted during this report period. This core team, along with regular help from MMS personnel, has provided the project with consistent, high quality data collection with notable efficiency.

During this report period, all monitoring sites were sampled as scheduled (Table 1) with no major problems. Data up to and including the Spring 2003 season have been graphed and are included below. This report includes, for the second time, data from the recently established site at Point Fermin. We now have four years of data for this site, and these are treated separately below. We also include data from our two sites on Santa Catalina Island. These data have not been included in previous reports because they had been sampled without funding. They have, however, been included in the funding cycle reflected by this report. The graphs for these two sites do not include the Spring 2003 data, as they were sampled too late to be included in this report.

Table 1. Sampling schedule for Fall 2002 and Spring 2003.

Location	Date	Researchers	Comments
Bird Rock	Oct. 18	J. Engle, S. DeJong, S. Lee, K. Miller, J. Wible	UCSB with UCLA and USC help
Little Harbor	Oct. 19	J. Engle, S. DeJong, S. Lee, K. Miller, J. Wible	UCSB with UCLA and USC help
Old Stairs	Nov. 3	S. Lee, S. Bergquist, M. Venkatesan, M. Myers	UCLA personnel
Point Fermin	Nov. 4	S. Lee, S. Bergquist, M. Myers, A. Bull, F. Piltz	UCLA and MMS personnel
Paradise Cove	Nov. 5	S. Lee, S. Bergquist, M. Venkatesan, F. Piltz, D. Pancer	UCLA and MMS personnel
Mussel Shoals	Nov. 6	S. Lee, S. Bergquist, M. Venkatesan, M. Myers, Ann Bull, Dave Pancer	UCLA and MMS personnel
Coal Oil Point	Nov. 19	S. Lee, S. DeJong	UCLA with UCSB help
White's Point	Nov. 20	S. Lee, S. Bergquist, M. Venkatesan, F. Piltz, M.E. Dunaway	UCLA and MMS personnel
Arroyo Hondo	Dec. 2	S. Lee, S. Bergquist, M. Venkatesan, M. Pierson, M.E. Dunaway	UCLA and MMS personnel
Alegria	Dec. 3	S. Lee, S. Bergquist, M. Venkatesan, A. Bull, M.E. Dunaway	UCLA and MMS personnel
Carpinteria	Dec. 4	S. Lee, S. Bergquist, M. Venkatesan, F. Piltz, A. Bull, M. Hill, C. Martin	UCLA and MMS personnel plus USFWS help
Paradise Cove	Mar. 1	Steven Lee, Meera Venkatesan, Ann Bull, Maurice Hill, Catrina Martin	UCLA personnel with MMS and USFWS help
Mussel Shoals	Mar. 2	S. Lee, M. Venkatesan, A. Bull, Dave Panzer, C. Martin	UCLA personnel with MMS and USFWS help
White's Point	Mar. 3	S. Lee, M. Venkatesan, Fred Piltz	UCLA personnel with MMS help
Coal Oil Point	Mar. 13	S. Lee, Kathy Pfeifer	UCLA personnel with SB County help
Old Stairs	Mar. 14	S. Lee, M. Venkatesan, M. Hill	UCLA personnel with MMS help
Alegria	Mar. 16	S. Lee, M. Venkatesan, K. Pfeifer, Mary Elaine Dunaway	UCLA personnel with MMS and SB County help
Carpinteria	Mar. 17	S. Lee, M. Venkatesan, K. Pfeifer	UCLA personnel with SB County help
Point Fermin	Mar. 18	S. Lee, M. Venkatesan, D. Panzer	UCLA personnel with MMS help
Arroyo Hondo	Mar. 27	S. Lee, M. Venkatesan, K. Pfeifer	UCLA personnel with SB County help
Coal Oil Point	Mar. 28	S. Lee, M. Venkatesan	UCLA personnel
Carpinteria	Mar. 28	S. Lee, M. Venkatesan	UCLA personnel
White's Point	Mar. 29	S. Lee, M. Venkatesan	UCLA personnel
Bird Rock	May 11	J. Engle, S. DeJong, K.A. Miller, J. Wible	UCSB and USC only
Little Harbor	May 12	J. Engle, S. DeJong, J. Wible, H. Chomeau	UCSB and USC only

Several new plots were established and monitored in the Spring 2003 sampling season. At Coal Oil Point, we established a set of five mussel photoplots on an expansive mussel covered bench that occurs just upcoast of the other plots. The plots were set up from downcoast (M1) to upcoast (M5). Mussel cover was dense but not always 100% at the start. Care was taken to avoid other research markers that occurred in the area. An old 8" diameter vertical pipe occurred just inshore of the M1 plot and this was considered a good reference point, so no reference bolt was affixed. Photos (overview and for scoring) were taken on the first day of setup, but for logistical reasons motile invertebrates and interbolt measurements were taken on a follow-up visit. At Point Fermin, a set of five 1m-radius circular *Lottia gigantea* plots were established along with three contiguous seastar irregular plots. All of these plots were located in the general vicinity of the previously established mussel plots. In order to minimize the number of bolts, the new *Lottia* plots were established using the existing bolts of the mussel plots. For four of these plots the main, notched (upper left) bolt of the mussel plots was used, but for one (*Lottia* #3), the upper right, un-notched bolt was used to avoid overlap of the circular plots. The numbering of the *Lottia* plots corresponded with that of the mussel plots. The seastar plots were established on the same bench and encompassed the five mussel/*Lottia* plots. The corners of these irregular plots followed terrain features but due to time constraints, no bolts were installed. Instead, a series of photographs was taken to document the position of the plots for future bolt installation. The initial sampling of the *Lottia* and seastar plots was done on the day of their creation. The only other site where additional plots might be established is White's Point. That site could probably support a set of seastar plots and a set of *Lottia gigantea* plots. This year saw the continued sampling of many of the recently established plots such as surfgrass and seastars at Alegria, *Lottia gigantea* at Carpinteria, *Lottia gigantea* at Mussel Shoals, and seastars at Paradise Cove.

This spring marked the fifth season of motile invertebrate data collection within the photoplot quadrats, an effort aimed at obtaining better estimates of mobile invertebrate abundances as well as possible relationships between invertebrate abundances and the cover of key species in our quadrats. Mobile invertebrate data were taken within *Chthamalus*, mussel, *Endocladia*, and *Pelvetia* photoplots. In addition, starting in Fall 2001, motile invertebrates were surveyed in all *Pollicipes* plots and in *Balanus* plots at White's Point. No mobile invertebrate data were collected within anemone plots at any of the sites. The motile invertebrate sampling protocol has remained in the development stage and has still not been implemented by all MARINE groups. In an attempt to solidify the methods, a three person sub-committee (Steven Lee, Dan Richards, and Melissa Wilson) was formed to develop a standardized protocol. During the Fall 2002 sampling, the revised methods were tested and our final recommendations were offered to the rest of the MARINE groups prior to the Spring sampling. While the bulk of the protocol remained intact, the most significant changes were in the way certain taxa, such as placed in three locations within each 50 x 75 cm photoplot (upper left, center, lower left). This sub-quadrat was further subdivided into four quadrants by monofilament line. Littorines plus small (<5 mm) and medium (5 mm – 15 mm) limpets were counted within these sub-quadrats. Large (>15 mm) limpets and all other motile invertebrates were counted within the entire upper left quadrant of each sub-quadrat. Sampling of littorines is still limited to the *Chthamalus* barnacle plots, and only limpets occurring on rock, not those on mussels, are counted. This method represents a significant improvement over the old motile invertebrate protocol, eliminating much time and risk of ambiguity and increasing the likelihood that it will be adopted by all members of MARINE. At our sites, the Spring 2003 sampling marked the second season of the revised methods; we feel the methods are useful and worth adopting by the other groups. The methods

take some time to get used to, but once in place, can be employed without an unreasonable time commitment.

Throughout this past year, we have been making the transition to the use of digital photography, and this conversion has now been fully implemented. Beginning in the Fall 2002 season, all photoplots were photographed using the new digital photographic methodology adopted by MARINE. In doing so, our Olympus 4040 digital camera was attached to our existing photoframer, and two images of each photoplot were taken. Due to problems associated with the use of the underwater housing, all photographs were taken without the housing and associated strobe assembly. The digital camera was merely attached to the normal Nikonos mount and the photos are taken using the camera's built in strobe. The two photos were taken using different flash settings, unlike with the Nikonos where different f-stops were selected. For the first photo the camera was set to automatic so it determined the proper strobe setting, and for the second photo a full flash was manually forced. All 360 degree photographic survey pans were taken using the digital camera as well. In the Fall, a duplicate set of photoplot photographs was taken using our old Nikonos setup, but in the Spring 2003 sampling, no emulsion (slide) photographs were taken, even as backup. The ease of obtaining and double checking the quality of images, together with the storage capabilities of the modern computers and storage media, means we no longer have to worry about being conservative with the number of photographs we take. Therefore, we do not hesitate to take a third of fourth photo of a particular plot if we want to adjust lighting or exposure, plus we have added additional photographic reference points. In the office, all images are downloaded onto the computer, organized and labeled. After choosing the best two images and deleting the rest, the photoplots are now scored electronically using the new 19 inch flat panel monitor recently obtained through MMS. Images are opened in Adobe Photoshop and a grid of 100 evenly spaced points is placed over the photo for point intercept scoring. The point layer can be temporarily removed if necessary to identify the image on the layer below. Scoring proceeds using the same rules applied to emulsion film slides. We have instituted a standardized system of nomenclature for all of the digital photographs and file folders and these will continue to be archived and distributed to the different MARINE groups as appropriate. We continued this year to use still photo surveys rather that video surveys at all of our sites.

We have continued to monitor barnacle recruitment at most of our intertidal sites. In addition to the *in situ* measurements and recruitment plates that we exchange during our normal Spring and Fall sampling, we are also revisiting the sites in the summer months to collect additional barnacle data. We have been getting close to 100% recovery of the recruitment plates each season. The exception is Carpinteria, which has very soft mudstone substrate that doesn't hold the masonry anchors very well. At this site, we have been losing one or two plates each season. After collecting the old plates from the sites, we have been sending the plates and data sheets to the UCSC group, who has been maintaining the barnacle recruitment database. The summer 2003 barnacle data have yet to be collected. One change that occurred this year, implemented for the first time during the Fall 2002 sampling season, is the replacement of the grooved barnacle recruitment plates by plates with "Safety Walk" grip tape attached to the top surface. This grip tape has a micro-rugosity that more closely resembles that of natural rock surfaces, and thus represents a substantial improvement over the old grooved plates. Because this new settling surface is uniform, the need to record the orientation of the plate upon attachment has been eliminated.

Many of these protocol revisions have been driven by the current contract between MARINE groups and SCCWRP to develop a database management system (DMS) for this project. To this end, several synopses of our inventory database were completed and submitted to SCCWRP to assist them in their endeavors. These included the creation and completion of several tables outlining definitions of all taxa categories used in our field data sheets and/or our computer data spreadsheets, as well as timelines for when each category was used, modified, or abandoned. Through this data standardization process, which included several DMS meetings, a new set of "Core Taxa" and corresponding field data forms were created, which were to be adopted by all MARINE groups. These changes were implemented for the first time in this recent Fall 2002 sampling season, and certain adjustments had to be made to the Excel computer files before these new data could be entered. Several old categories that were very broad have been abandoned, and several new categories have been created. Clear relationships between these new and old categories have been outlined to ensure that past and future data remain comparable. This DMS had resulted in a uniform Access database that will be used by all groups. This process is nearing completion and an early beta testing version of the database has been released. Steven Lee of UCLA volunteered to be the beta tester for entering data into the new database, and is currently communicating with Larry Cooper of SCCWRP regarding the bugs that were discovered during beta testing.

In late September (Sept. 20-21), a taxonomy workshop was held at the UC Santa Barbara campus. This workshop was attended by most of the researchers associated with this project, plus David Lindberg and Paul Scott, who acted as taxonomic experts for limpets and mussels, respectively. The workshop was very useful, but further workshops should include field visits to the various sites in the MARINE network. Steve Lee continued to be involved with the CIRP cruises led by Jack Engle. He attended two research cruises during this report period, including the Fall 2002 trip to Catalina during which the two monitoring sites (Bird Rock and Little Harbor) were sampled. Beginning in early July, time was spent organizing, labeling and becoming familiar with a large collection of newly purchased items, including a new vehicle, a mapping grade GPS, office equipment, and other miscellaneous items (purchased from other funds but expected to be used in this project).

After the regular Spring 2003 sampling was completed, all of the mainland sites (Alegria to Point Fermin) were visited again in order to do some mapping surveys and general site maintenance (Table 1). Using our new high resolution GPS we collected position data for all of our plots and bolts, plus we mapped out many of the terrain features and the general boundaries of each site. All BLM markers, reference bolts, video reference points, and plot identification bolts were surveyed, as were transect lines and plot areas. In addition, we used our laser leveling equipment to obtain the elevation of all the bolts relative to the recently installed BLM markers (for which accurate elevation data will be available).

Future Plans

During the upcoming summer months, we will be revisiting all of our sites for the Summer 2003 barnacle recruitment sampling. There is still a question as to when the new Microsoft Access database will be ready, but in the meantime, we entered all of the Spring 2003 data into the existing Excel files for the creation of this annual report. Once the final version of the new Access database is distributed, we will re-enter the Spring 2003 data as appropriate. Once all of the high resolution GPS data are collected and we receive the accurate position data from the

BLM markers, a new set of site maps can be generated. This is an important time to do this because of all the new plots we have been establishing at the sites. We still need to begin collecting voucher specimens from the sites.

Problems Encountered

We were unable to sample the mussel plots and sea star transects during Fall 2002 at Carpenteria due to seals on the rocks. The seals were not present during Spring 2003, however, and we were able to complete all of the surveys at that site. Heavy surf was a hindrance during most of the Spring season, with many extra field days required due to cancelled sampling or partially finished sites. At White's Point, a rogue wave swamped our sampling gear, flooding our metal detector. We immediately disassembled and dried it so it wouldn't be destroyed, but in the process broke the solder connections to the speaker. The metal detector still works, but only by using a set of headphones connected to the audio jack. While retrieving equipment dispersed by the large wave, a second even larger wave swept over the protective offshore rock formation and overwhelmed two of the sampling personnel. While one person (Meera Venkatesan) simply got wet, the other person (Fred Piltz of MMS) lost his footing during an evasive maneuver and was injured (luckily, not critically) as the wave enveloped him.

MMS Action Required

None

Data Summary

Although we have not completed a full analysis of the past year's data, in this section we provide graphical summaries of the data to date, as well as brief narratives about possible trends.

Photoplot data

Figure 1. Trends in *Chthamalus* cover at all sites monitored. *Chthamalus* cover nearly doubled at Mussel Shoals in Fall 2002 after a sharp decline during the previous spring. Barnacle cover also increased slightly at Old Stairs over the sampling period, while remaining relatively stable at the other sites. Cover at Bird Rock remains approximately half of its original value.

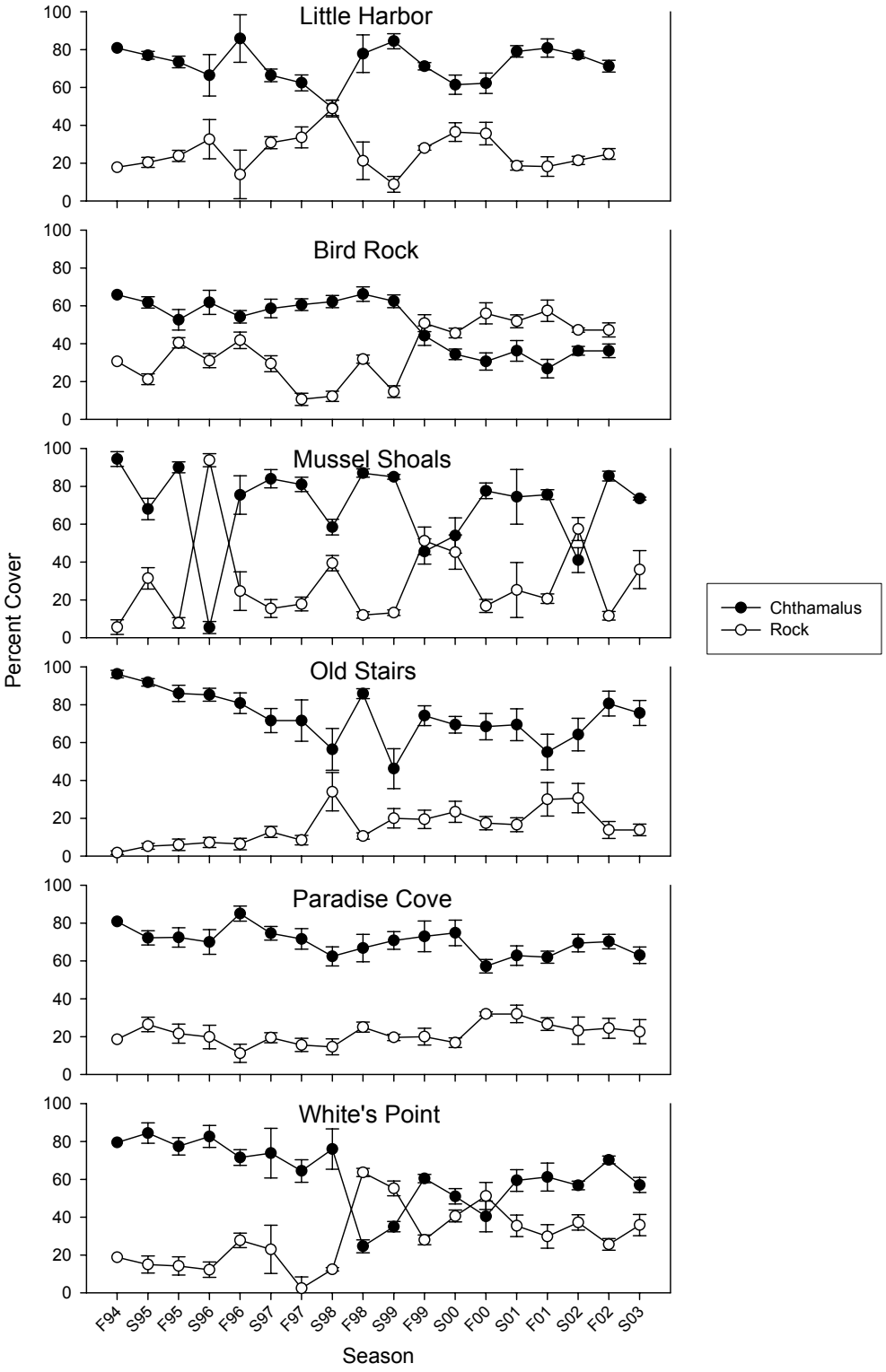


Figure 2. Trends in *Mytilus* cover at all sites monitored. *Mytilus* cover has remained roughly stable at most of our sites with only slight fluctuations. One notable exception is at Old Stairs where mussel cover underwent a sharp decline in Fall 1995, and after increasing a bit in Fall 1999 has remained at a lower stable level since. Bird Rock and Little Harbor have also experienced greater variability in mussel cover. Slight increases in mussel cover have been seen at both of these sites following declines in Spring 2001.

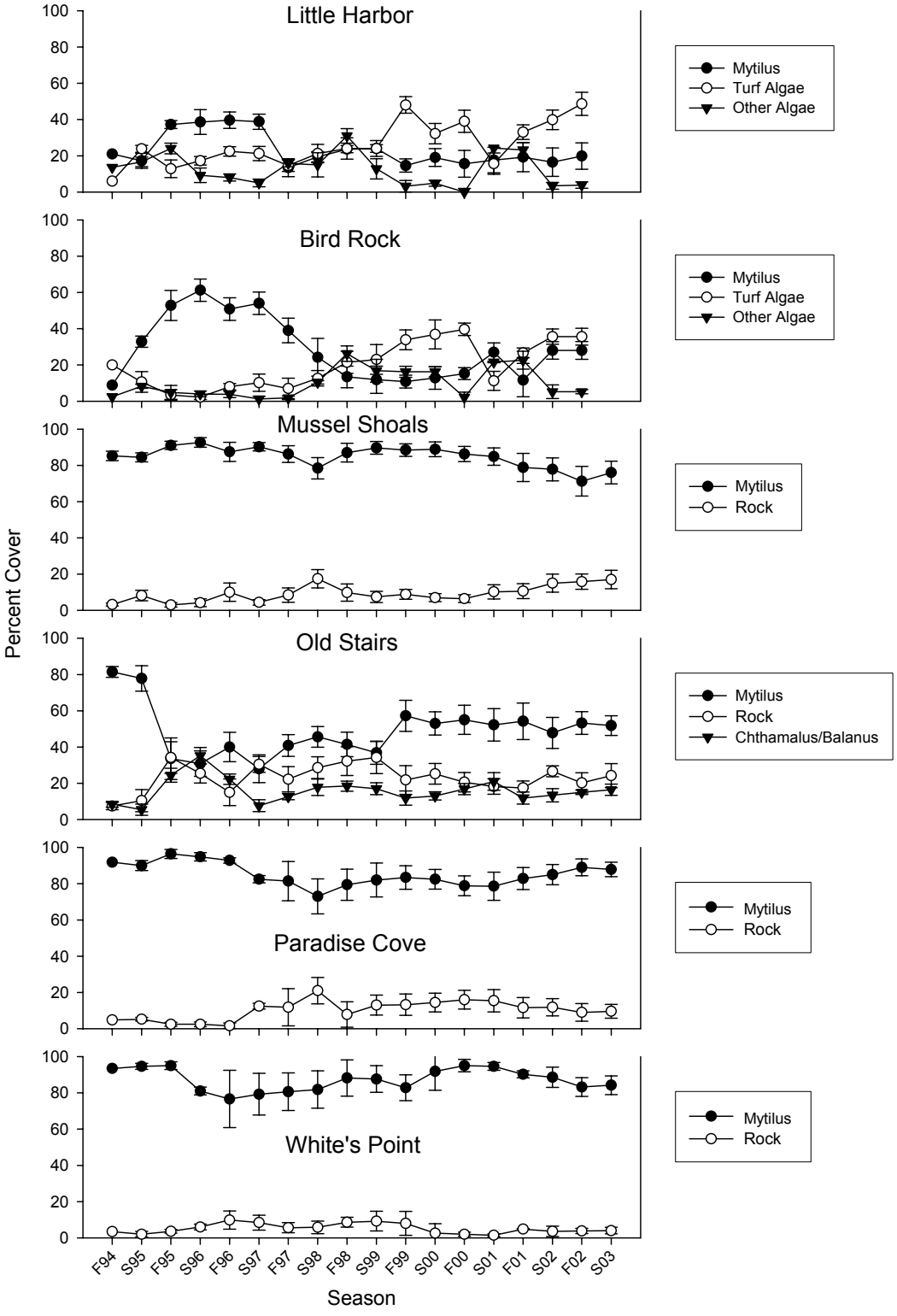


Figure 3. Trends in *Endocladia* cover at all sites monitored. *Endocladia* cover at Old Stairs has been quite variable throughout the study. After a modest increase in Spring 2001, *Endocladia* was again near the low end of the cover we have recorded by Fall 2002, though it showed a slight increase the following Spring. All sites seem to show seasonal patterns in cover, with at least slight increases in the spring. At Paradise Cove, *Endocladia* cover has been increasing throughout the study, and rebounded this season from last spring's slight decline. Interestingly, qualitative observations show *Endocladia* to be spreading up further into the barnacle zone over the past couple of years. White's Point, which has been experiencing a gradual decline, seems to be on the rise again. Cover increased dramatically this spring to the highest level since Spring 1998.

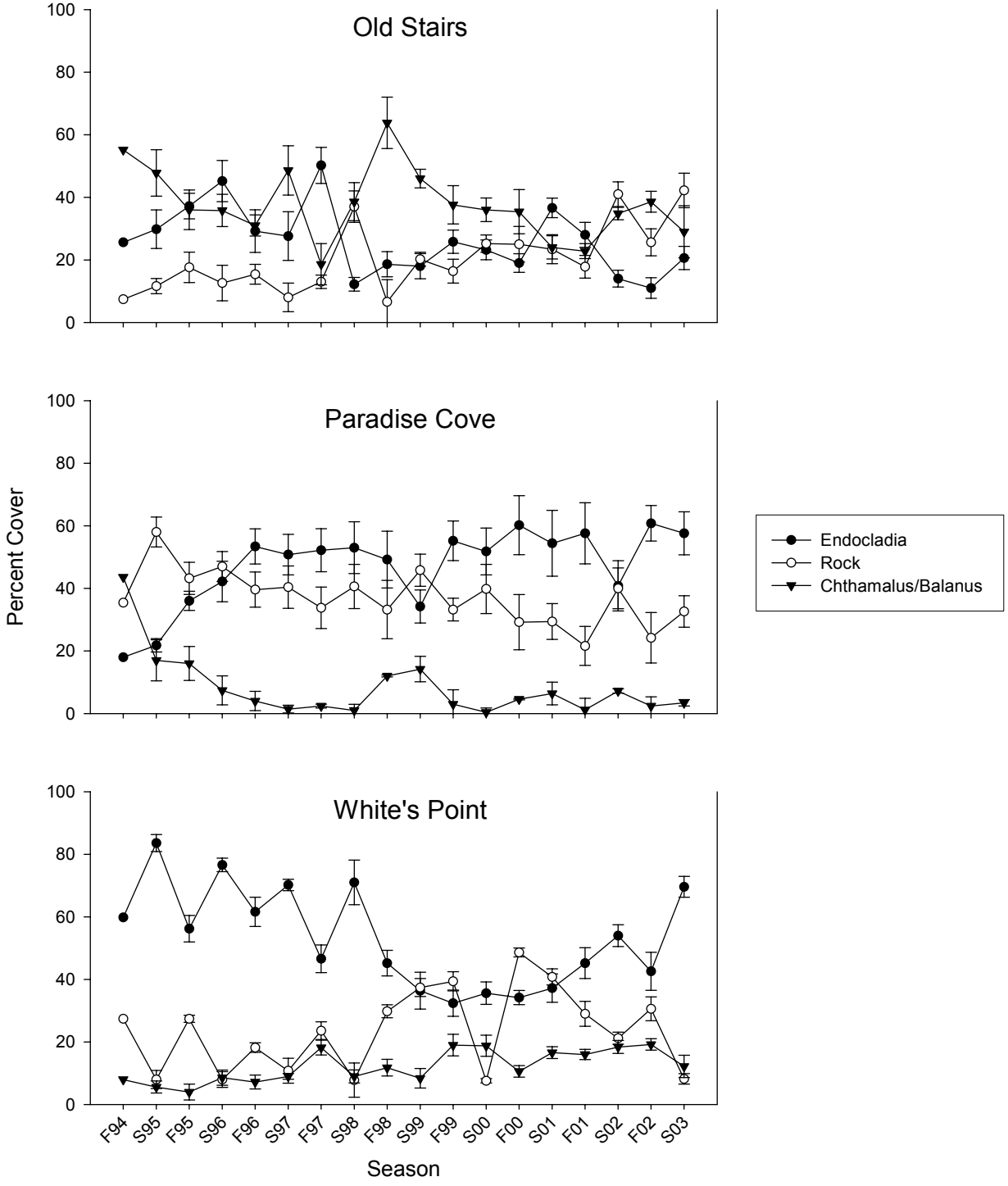


Figure 4. Trends in *Anthopleura* cover at all sites monitored. *Anthopleura* cover at Old Stairs has been marked by rapid increases followed by gradual declines. While qualitative observations do support this pattern to some extent, other factors such as sand burial also contribute to the apparent decline. This year, anemone cover rebounded to previous levels after a decline in Spring 2002, which may have been a reflection of very high sand levels in the plots. Mean cover at Mussel Shoals has declined overall, but has been roughly stable since Spring 1999. The variance, however, appears to have increased since that time as evidenced by the wide error bars. This pattern is almost certainly due to anemone plot #5, which has been almost entirely overgrown by mussels. The other plots, and the site overall, seem to have stable or even increasing cover of *Anthopleura*.

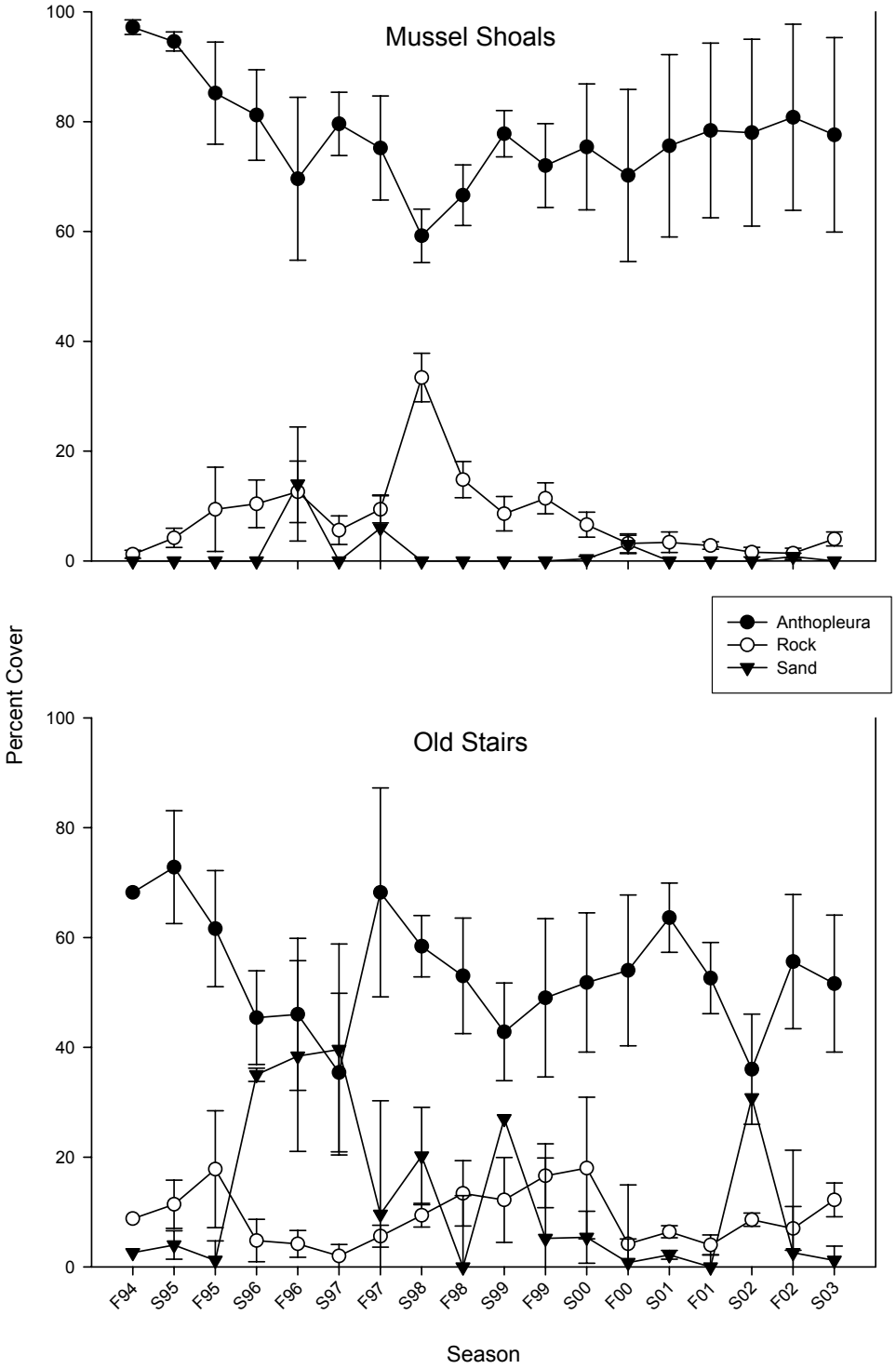


Figure 5. Trends in *Gelidium* and *Pollicipes* plots at Bird Rock. This figure shows the cover of species within *Gelidium* and *Pollicipes* plots at Bird Rock on Catalina Island. These data have not been included in previous reports because sampling was done without funding. Within *Gelidium* plots, sessile invertebrate species exhibited low and relatively stable cover. *Gelidium*, however, has undergone substantial fluctuations. It is unclear what is responsible for these fluctuations, but it is likely due to the contributions of other red algae such as geniculate corallines and low turfy species. These plots are extremely difficult to score and *Gelidium* is only recorded when the identification is certain. Much of what is considered turf is likely low-growing *Gelidium*. Future graphs will include these other red algae species. Within the *Pollicipes* plots, mussels and *Pollicipes* have co-varied through the seasons with mussels dominating the plots for the majority of the time. After an early decline, mean *Pollicipes* cover has increased gradually since the spring of 1996.

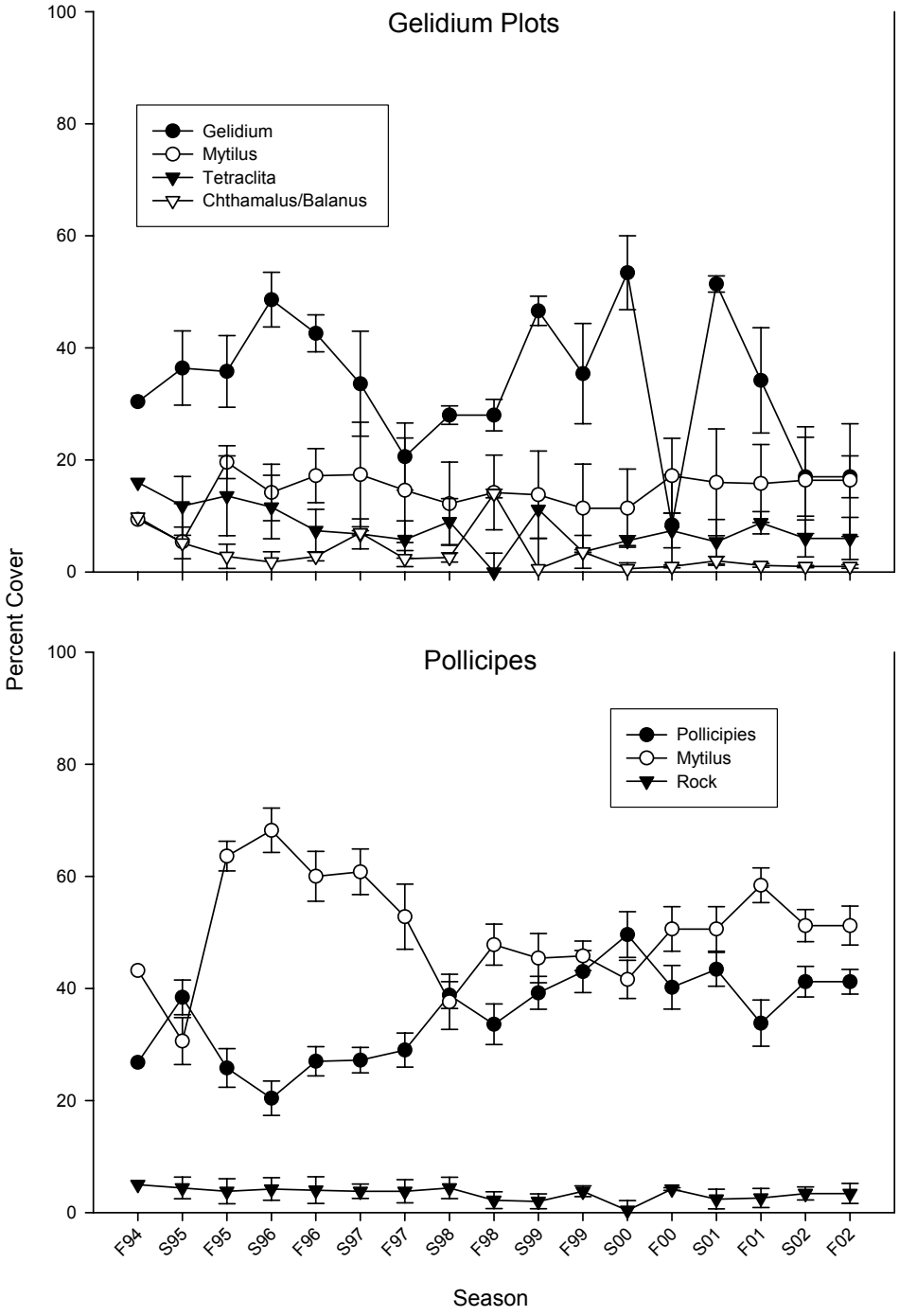


Figure 6. Trends in *Sylvetia* plots at Catalina Island. This figure shows the cover of *Sylvetia* (formerly *Pelvetia*) at the two Catalina Island sites. At Bird Rock, mean *Sylvetia* cover has declined by about 20% since the first survey. Cover was the lowest in Fall 1998 and has been at a slightly higher level since Fall 2000. However, since Fall 1998 the variance among the plots has been substantially larger. At Little Harbor, mean *Sylvetia* cover is at its highest level since the beginning of our monitoring period. Cover increased for the first two and one half years, declined to near the original level between 1997 and 1999, and has increased since. The suggestion of seasonal variation can be seen in these data, but they are mostly obscured by larger, non-seasonal changes.

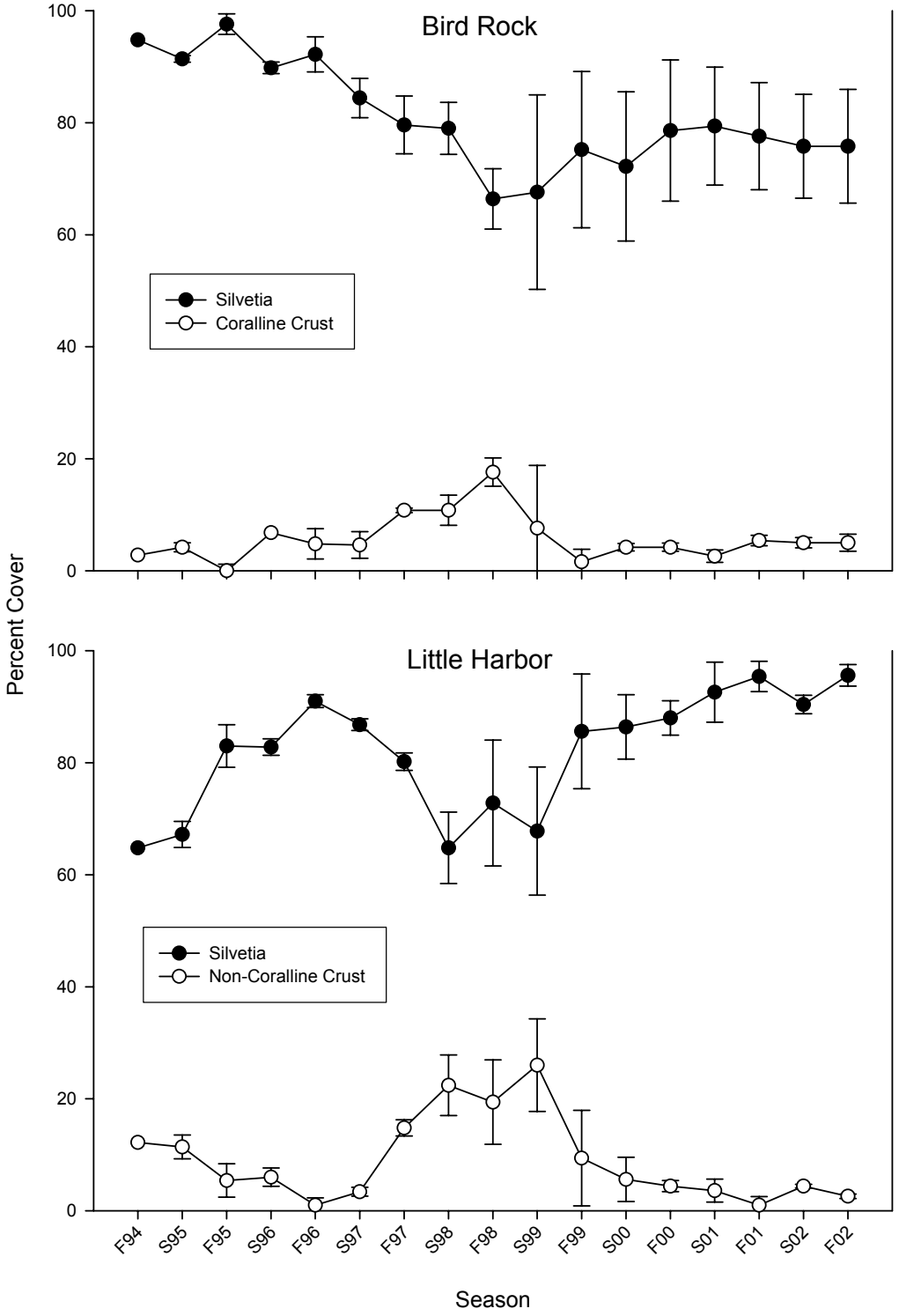
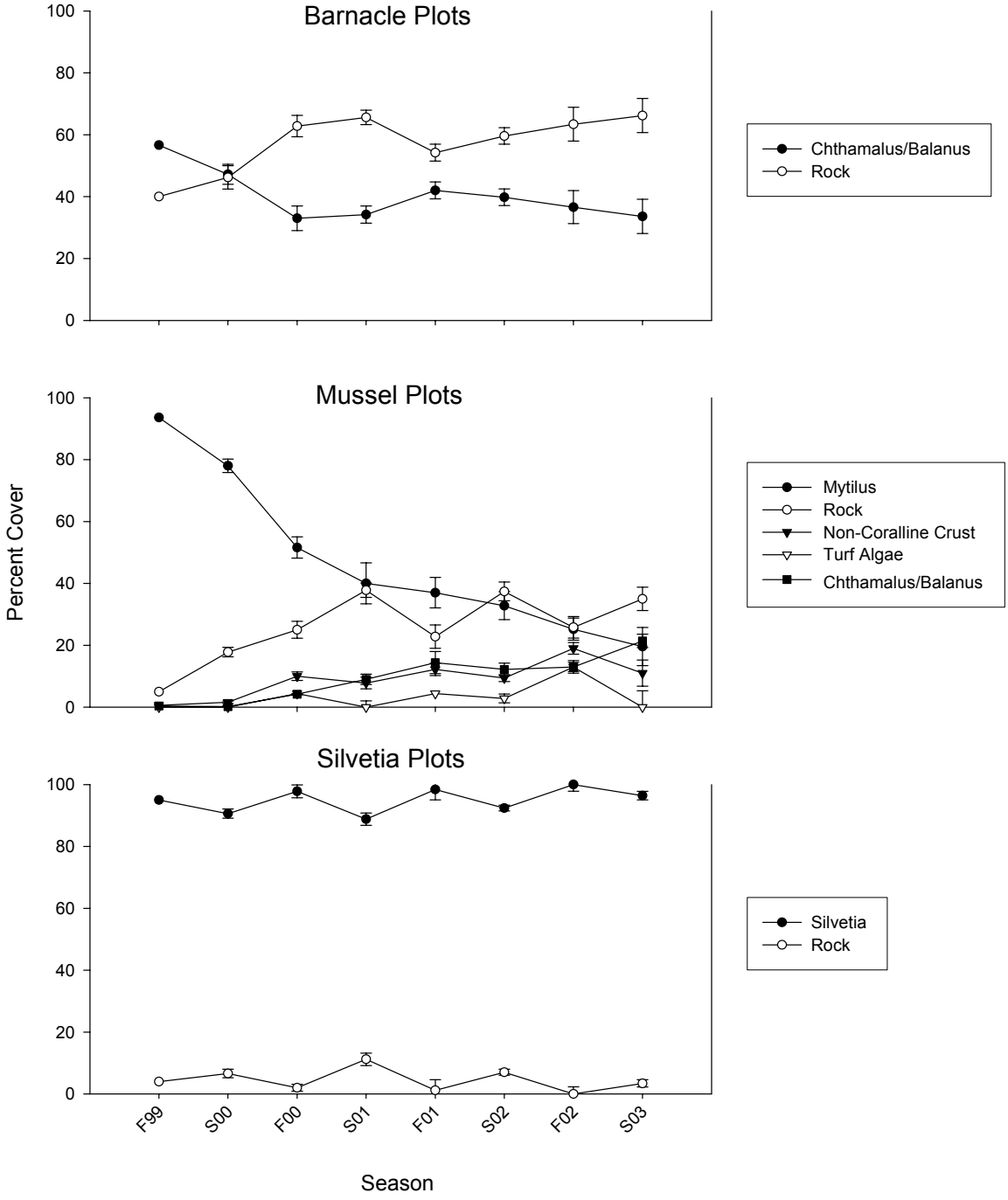


Figure 7. Photoplot data from Point Fermin. This figure shows the cover of species monitored within photoplots at Point Fermin since the first sampling in Fall 1999. This is the second time these data have been included in the annual report. Both *Chthamalus* and mussels have declined since the plots were established. Mean *Chthamalus* cover declined in the first two sampling seasons from an initial high of ~60% to <40%, and still seem to be declining gradually. Mean mussel cover was very high when the plots were established (over 90%), but has been declining with every subsequent sampling season. In the first two years, this decline was rapid (from >90% to ~40%), and in the last year it was more gradual with an overall decline of over 60%. This decline is more severe than we would normally expect from random processes after the establishment of a plot. *Sylvetia* cover has shown seasonal variation over the last three years, but with no apparent decline. Our qualitative observations support these patterns for the site as a whole. Mussels seem to be getting sparse, at least in the vicinity of our plots, and *Sylvetia* seems to be very healthy if not increasing at the site.



Phyllospadix Transects

Figure 8. Percent cover of *Phyllospadix* at Mussel Shoals and Paradise Cove. At Mussel Shoals, *Phyllospadix* cover had experienced a marked decline following a peak in Fall 1995 and has seemed to stabilize at around 40% cover since 1998. In the past year there was a slight increase in the fall followed by a slight decrease in the spring. At Paradise Cove, *Phyllospadix* cover seems much more sporadic with stronger seasonal pattern than at Mussel Shoals. Cover at Paradise Cove underwent a precipitous decline following Fall 1996, and has been increasing episodically ever since. Fall 2002 experienced the highest *Phyllospadix* cover yet, followed by a drop back to the level of previous seasons (around 50%) in Spring 2003. The sharp declines at both of these sites demonstrate the succession patterns common following disturbance. Concurrent with the declines was a sharp increase in the cover of bare substrate. Since that time, increases in other algae (mostly filamentous and turf species) followed by an increase in *Egregia* (at Mussel Shoals) were seen.

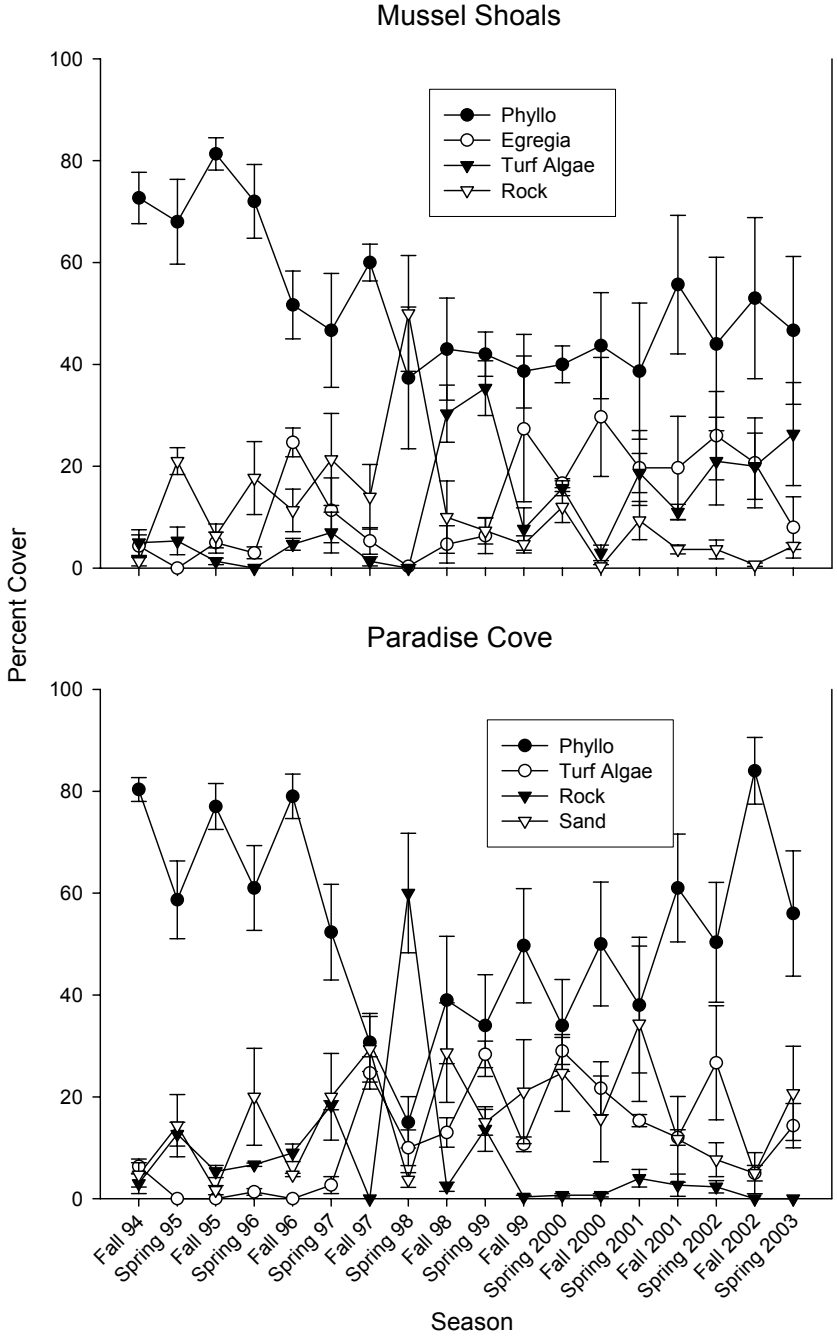
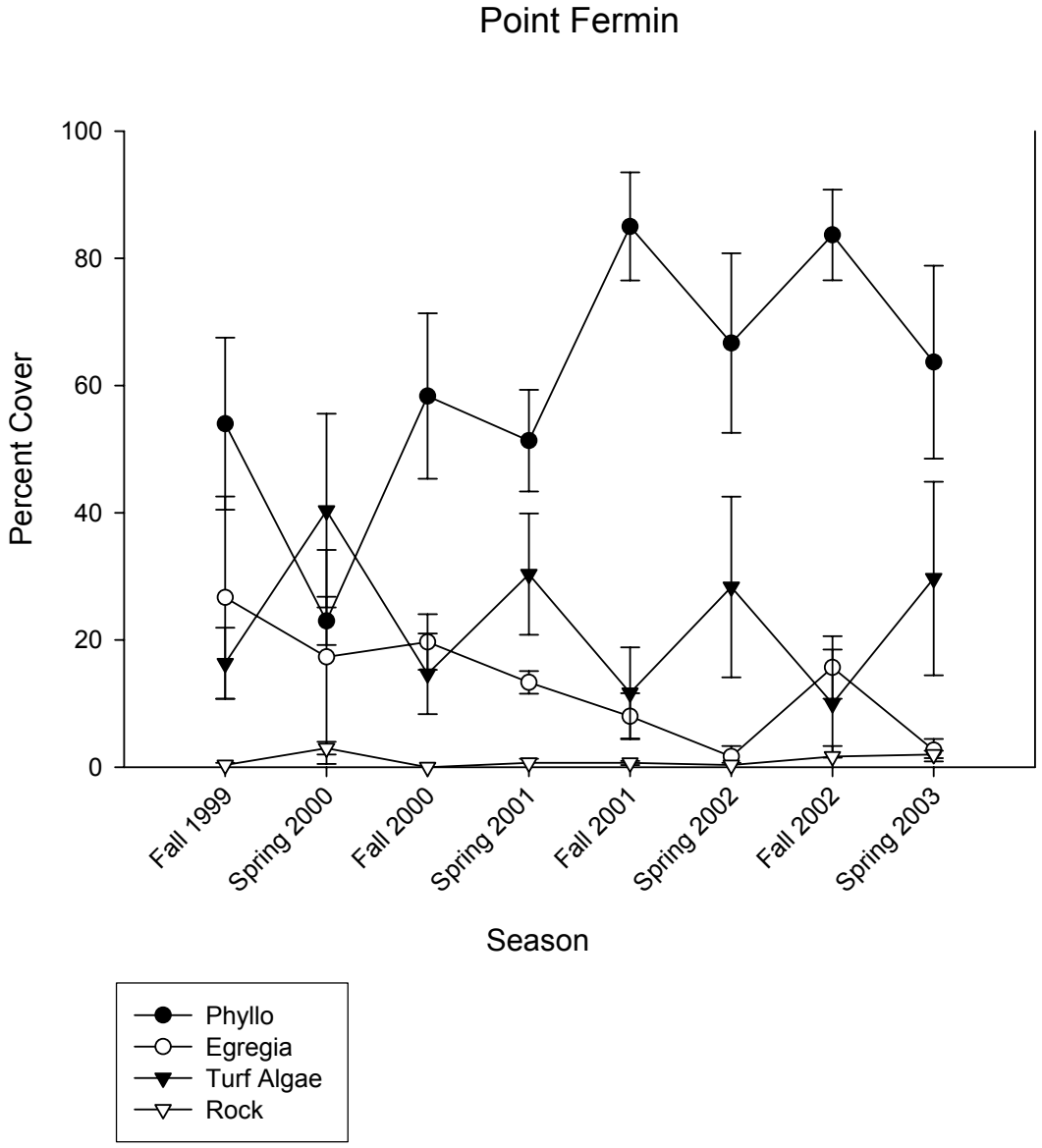
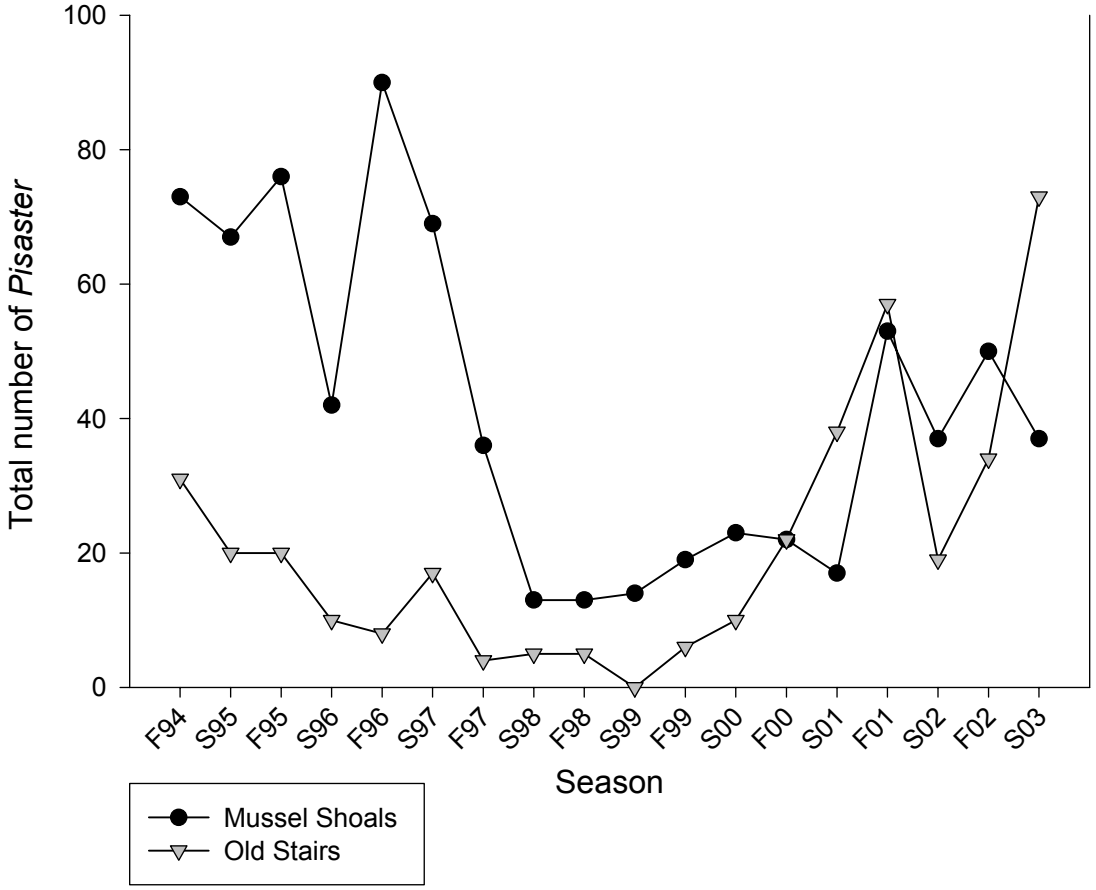


Figure 9. Percent cover of *Phyllospadix* at Point Fermin. Within the surfgrass transects at Point Fermin, bare rock or sand are uncommon. *Phyllospadix* seems to show seasonal patterns similar to the other sites with higher cover in the fall than in the spring. Cover seems to have increased since the first sampling in Fall 1999, with opposing cover of algae reflecting its seasonality. *Egregia* has become less common since the beginning of the surveys, at least in the vicinity of the transects.



Pisaster Plots

Figure 10. Total number of *Pisaster* within monitored plots at two sites in Ventura County. The total number of *Pisaster* found at our two Ventura sites dropped significantly throughout the first years of the study. In recent seasons, however, the numbers seem to have increased substantially, a trend that follows observations throughout Southern California. The numbers dropped again at both sites during Spring 2002 and, at Mussel Shoals, remained in the same range this year. At Old Stairs, however, sea stars increased dramatically in Spring 2003, reaching an all-time high. Sea star abundance at our sites, especially Old Stairs, seems to be highly dependent on the degree of sand inundation, and this certainly seems to have had an impact on the apparent decline seen in our data last year. The decline at Mussel Shoals seems to have less to do with sand.



Lottia Plots

Figure 11. *Lottia* abundance at two sites in Ventura and L.A. counties. *Lottia* abundance at Old Stairs and Paradise Cove has remained quite stable throughout the study with little change throughout the first several years. *Lottia* abundance increased somewhat in 1999, especially at Paradise Cove. Abundance remains somewhat lower at Old Stairs, though still in the upper range of its abundance during the first few years. Numbers have been declining at Paradise Cove since the Fall 1999 peak, and continued to drop until this past spring season.

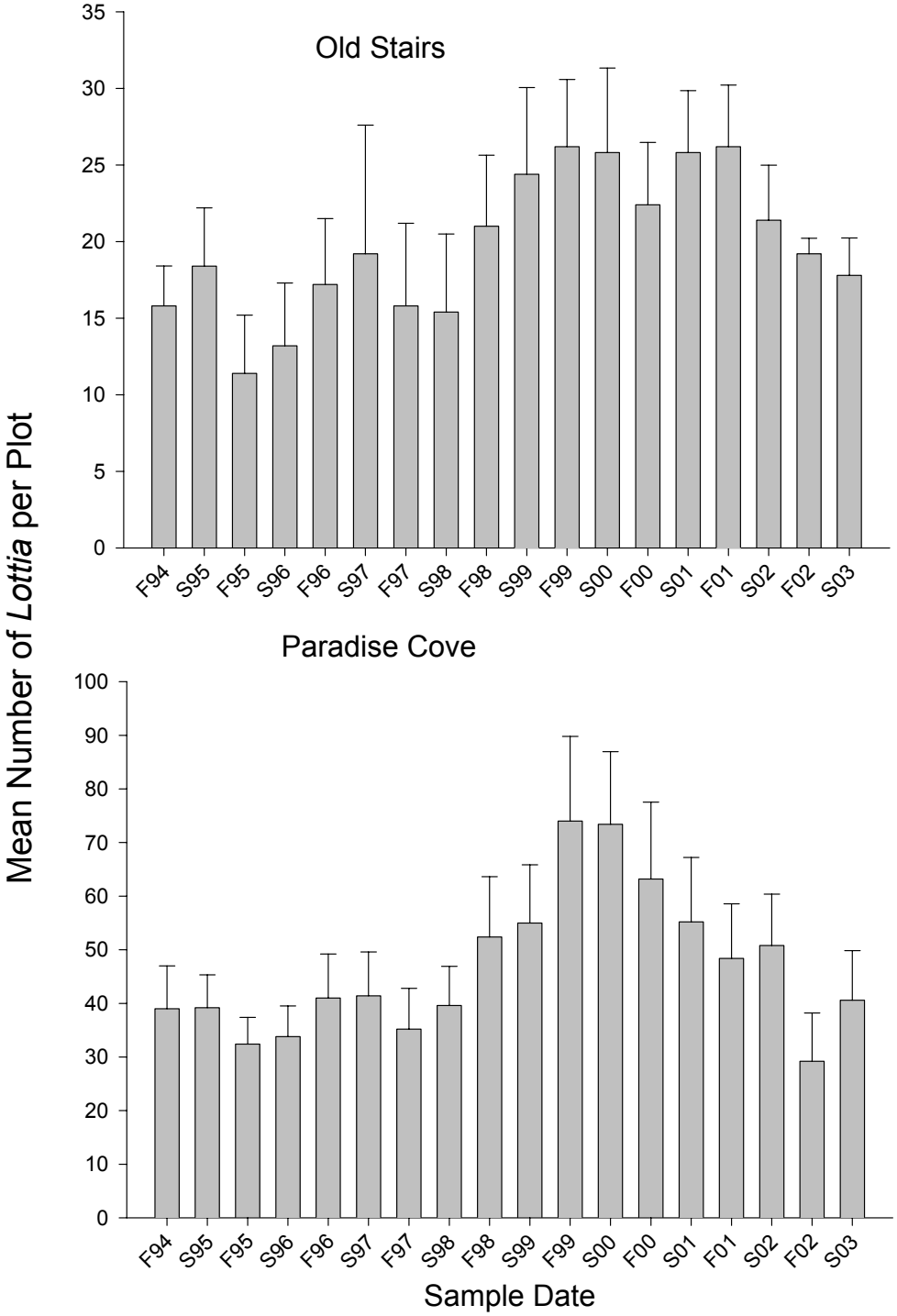
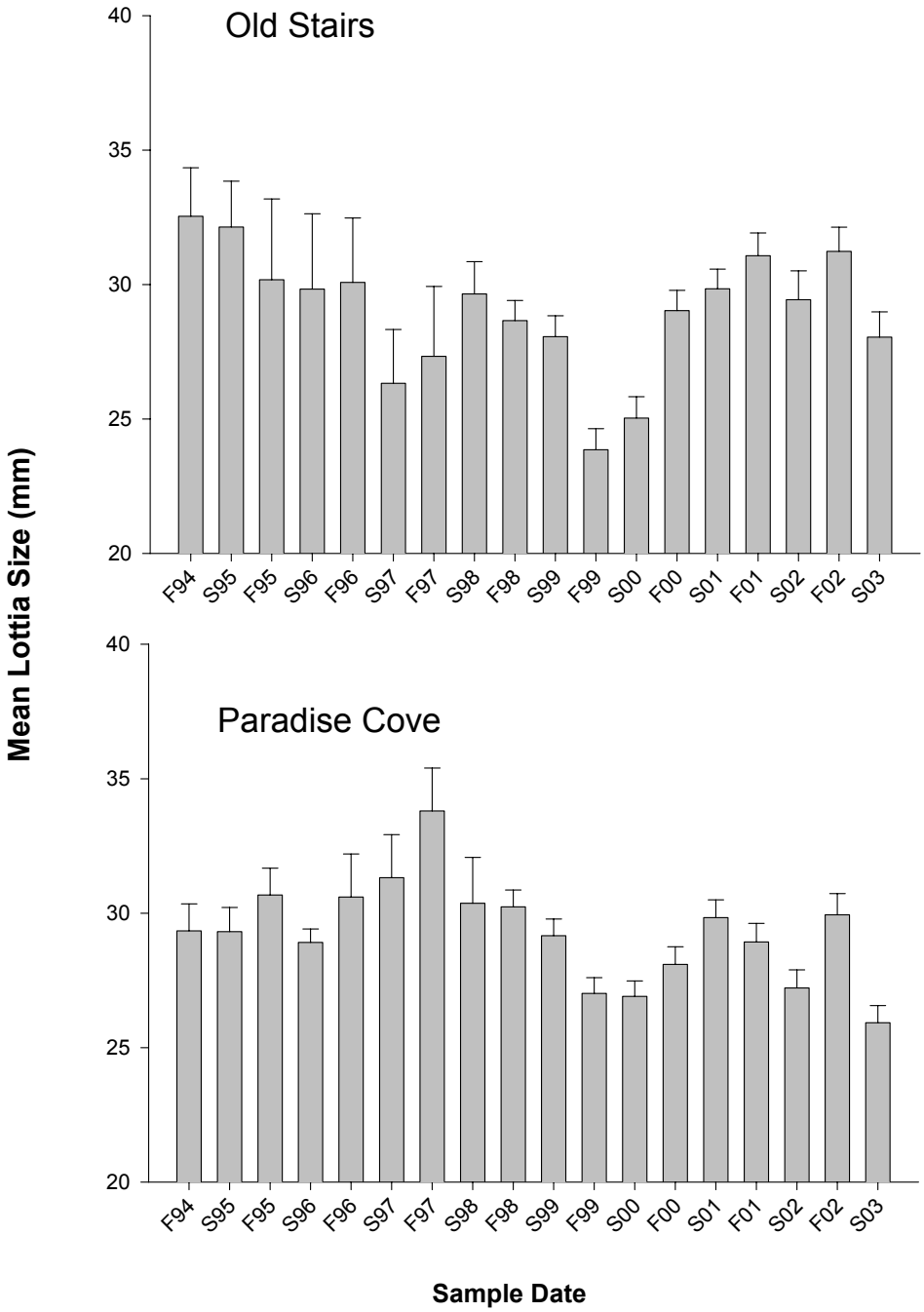


Figure 12. *Lottia* mean sizes at two sites in Ventura and L.A. counties. Mean *Lottia* size at Old Stairs has mostly remained stable throughout the study, but with a moderate drop after the Spring 1999 season. This drop in mean size corresponds to the increase seen in the abundance data, indicating that recruitment of small individuals led to the increased abundances. However, the change might also be due to a change in personnel that occurred during that time, with a possible increase in search image for smaller individuals. However, there have been fewer small individuals seen during the last several seasons (up to Fall 2002) and this is reflected in the small increase in mean size that is observed in the figure. A small decline in mean size was observed this spring. Mean *Lottia* size at Paradise Cove has been lower overall than at Old Stairs and has remained relatively stable over the study period. This spring, size dropped moderately to a new low after increasing slightly in the fall.



Task No. 17604: *Shoreline Inventory of Intertidal Resources of San Luis Obispo and Northern Santa Barbara Counties*

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

Summary of Research

This report summarizes the accomplishments of the Inventory of Rocky Intertidal Resources for San Luis Obispo and Northern Santa Barbara Counties from July 2002 to July 2003. The purpose of the Shoreline Inventory Project is to provide baseline information on the rocky intertidal plants and animals along the central and southern California coast. Information on coastal biota in these areas would be essential in the event of an oil spill or other major impact. In addition, the monitoring studies yield important data on population dynamics on a local and regional scale which can be utilized for more effective resource management as well as provide fundamental ecological knowledge about the dynamics of the systems. The rocky intertidal surveys of five sites in Northern Santa Barbara County (NSB) represent a continuation of previous semi-annual monitoring conducted for the Minerals Management Service from 1992 to 2002. Five additional sites were established in 1995 for San Luis Obispo County (SLO). A sixth site at which only black abalone and owl limpets are monitored was recently added in SLO County. The combination of previous and current year surveys in the two counties has resulted in a total of 23 semi-annual samples for NSB sites, and 16 semi-annual samples for SLO sites (with the exception of the newly added sixth site).

The sampling protocol focuses on target species or assemblages. Permanent photoplots are established in assemblages such as barnacles, mussels, anemones, turfweed, and rockweed. Cover of the major taxa is determined by point-contact photographic analysis for all plots except barnacles, which are scored in the field to allow samplers to distinguish *Chthamalus* spp. from *Balanus glandula*. Counts of mobile invertebrates occurring within the barnacle, mussel, *Endocladia, Mastocarpus, Silvetia*, and *Hesperophycus* photoplots are also done in the field. Additional permanent plots are established for large motile species such as owl limpets, black abalone, and seastars. Line transects are used to estimate the cover of surfgrass. Photographic overviews and field notes are used to describe general conditions at the site and to document the distribution and abundance of organisms not found within the photoplots.

Progress during 2002-2003

Over the past year, we have completed efforts to fully standardize our sampling methods with all groups in MARINE (Multi-Agency Rocky Intertidal Network). One of MARINE's goals is to develop a database for all of the intertidal groups to use for data entry. This goal is nearly complete, and we hope to begin using the newly constructed MARINE database sometime this summer.

Table 1 summarizes the field activities of this past fall and spring for both counties. All data, with the exception of the photoplots (see "photoplot species" section below), have been entered and analyzed for all work completed through spring 2003.

Table 1. Summary of Rocky Intertidal Field Activities for San Luis Obispo (SLO) and Northern Santa Barbara (NSB) Counties.

Dates	County	Activity
11/3-11/7	NSB/SLO	Fall 2001 sample
11/19-11/21	NSB/SLO	Fall 2001 sample
2/28-3/4	NSB/SLO	Spring 2001 sample
3/25-3/28	NSB	Spring 2001 sample

A species by species summary of the results of the past year's monitoring follows. The summaries are broken into 3 sections: Photoplot Species, Surfgrass, and Motile Invertebrates.

Photoplot Species

During the past year, we changed our protocol for sampling photoplot species. We switched from photographing the plots using a Nikonos with slide film and scoring percent cover of species within the plot by projecting the slide onto a grid in the lab to using a digital camera and scoring the images on a computer. To insure that we were getting images at the optimal resolution for our purposes, we needed to spend some time experimenting with different camera settings and examining the images in the lab. In addition, time was needed to switch over from scoring photoplot images using a slide projector and screen to scoring the digital images on a computer monitor. All of these changes in the protocol were accompanied by a change in the technician scoring the images, which required some training time. Because of these changes to the protocol and personnel, we were not able to completely process the photoplot data in time for this annual report. A full discussion of the trends for photoplot species will be provided in the final report that we will complete by the end of summer, 2003.

The one photoplot type that we do have data for is barnacles, since these were scored in the field in order to distinguish *Chthamalus* spp. from *Balanus glandula.* Total barnacle cover at two SLO sites (Pt. Sierra Nevada and Cayucos) increased slightly as compared to recent years. Plots at both of these sites contained no, or almost no *B. glandula*. Barnacle cover at one SLO site (Hazards) declined over the past year. Plots at this site contained about ½ *B. glandula* and ½ *Chthamalus* spp. and were exposed to frequent sand scour. Barnacle cover at the remaining sites stayed about the same as compared to recent years. The only site with consistently high cover was Shell Beach, where only *Chthamalus* spp. were present. Cover at two sites (Occulto and Stairs) remained extremely low. At Occulto the barnacle zone has shifted up in tidal height, and "barnacle" plots are now dominated by algae and mussels. Barnacles at Stairs have been steadily declining over time due to a lack of recruitment of new individuals into the site. At Government Pt., percent of total barnacle cover consisting of *B. glandula* increased from around 60% in F02 to nearly 95% in SP03. As with Occulto, the barnacle zone appears to have shifted upward in tidal height at this site.

Surfgrass

Surfgrass cover (*Phyllospadix* spp.) remained high over the past year at all sites except Stairs (NSB), where plots were decimated by the 1997/98 El Niño storms, and Shell Beach (SLO), where cover has gradually declined. All sites except Cayucos (SLO) experienced slight seasonal

fluctuations, with higher cover in the fall than the spring. Surfgrass transects at Cayucos are located within permanent pools, so it makes sense that there would be no seasonal differences in cover at this site. Only one surfgrass transect of three at Hazards (SLO) could be sampled during the past two sampling periods. The other two remained underwater at low tide.

Motile Invertebrates

Pisaster ochraceus are counted and measured in plots at each site, and also grouped into color categories. Seastar numbers have fluctuated at most sites over time, and counts for the F02/SP03 samples did not appear to be abnormally high or low at any site. Numbers were higher at Occulto during this past year as compared to previous years, but this was confounded by the fact that we had better than normal tides when we sampled Occulto in F02 and SP03, which made it possible to count seastars in areas that are often splashed by waves. *P. ochraceus* color ratios were approximately the same among sites, with about 25% orange and 75% falling under the "other" category (primarily purple, but also some "brown" individuals). The sites with the highest proportion of juvenile *P. ochraceus*. in the population were Boat House and Hazards, with approximately 40% of the populations consisting of individuals <40mm in radius.

Numbers of the owl limpet, *Lottia gigantea*, were stable at all sites except Stairs, where large swells hit the site in winter 2003 and removed portions of the reef where two of the five *Lottia* plots were present. Recruitment of *Lottia* into our plots was higher than average during the past year at Cayucos, Hazards and Government Pt. The fatal condition termed "withering syndrome" has caused drastic declines in black abalone (*Haliotis cracherodii*) populations as far north as Cayucos (SLO). Recovery of these decimated populations is unlikely as recruitment is thought to be very localized and the remaining individuals at these sites are probably too sparsely distributed to allow for successful spawning. Although evidence of withering syndrome was seen at Rancho Marino (the SLO site just north of Cayucos) in SP00, numbers have not declined as rapidly as expected. Abalone numbers at Piedras Blancas, just upcoast of Rancho Marino, were stable while those at the northernmost site (Pt. Sierra Nevada) continued to increase slightly. This increase was attributed to recruitment of black abalone into our plots during the period ranging from summer 2000-spring 2002.

In addition to monitoring seastars and owl limpets, we also count and measure the small motile invertebrates that occur within our photoplots. The protocol for monitoring these invertebrates has been modified somewhat over the past year to ensure that our methods are comparable to other monitoring groups (UCSB, UCLA, CSUF, and the Channel Islands National Park Service). Species targeted in these plots include *Tegula funebralis*, *Acanthina* spp., *Nucella emarginata*, *N. canaliculata*, *Ocenebra circumtexta, Lepidochitona harwegii*, *Nuttalina* spp., *Mopalia* spp., three species of *Pagurus*, *Littorina* spp., and various limpets. Limpet and littorines were the most abundant motile invertebrates found in the photoplots. Limpets were common in all plot types at nearly all sites, while littorines were most abundant in the higher barnacle and *Endocladia* photoplots. *Tegula* was also common and was found in all plot types, but was most common in the lower mussel and *Silvetia* plots. *Nucella* were most commonly found in mussel plots, their preferred prey in the central California region. Another whelk, *Acanthina*, was consistently found at only two SLO sites, Cayucos and Shell Beach. *Acanthina*, which feed on barnacles, were occasionally found in barnacle plots, but were most common in *Silvetia* and mussel plots. *Lepidochitona* was also most common under *Silvetia*, which is though to provide refuge from desiccation for the chiton, but like *Nucella* they could be found in other plot types in lesser

abundance. Another chiton, *Nuttalina*, was found almost exclusively in mussel plots. *Ocenebra* was rare or absent from most sites except in the mussel plots at Shell Beach, and the *Silvetia* plots at Cayucos.

The above patterns will be explored further in our upcoming DRAFT final report to MMS, which should be completed sometime in late August. It is hoped that additional funding will be secured to continue monitoring in these and other intertidal areas because this information is invaluable for providing insight into the long-term patterns and processes that structure the intertidal, as well as "baseline" information that can be used for assessing change in the event of an oil spill or other disturbance.

Task No. 17605: *Population Dynamics and Biology of the California Sea Otter at the Southern End of its Range*

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Summary of Research

Progress during 2002-2003

Progress on the project continues as projected in the study proposal: Table 1 summarizes the results of capture activities for all years of the study. In the northern study area (San Simeon) capture operations in October 2002 resulted in the addition of 16 new animals and the recapture of 4 previously implanted animals. In the southern study area (Pt. Conception) capture operations in April 2002 resulted in 11 new study animals. There were no injuries or mishaps during capture activities, and after surgery all study animals were released successfully and in good condition to their site of capture. We have now re-captured a total of 9 study animals for removal of Time Depth Recorders; an additional 3 instruments were retrieved after the death of the study animals during the normal course of the study. Analysis of archival data from the 12 retrieved TDR instruments is ongoing, however preliminary exploration of these data are encouraging, and indicate that time-depth data in conjunction with observational data will more than allow us to meet our study objectives.

Monitoring of study animals by radio telemetry is ongoing by fieldworkers based at Piedras Blancas field station, San Simeon CA. Data collection on movement patterns, activity budgets and foraging behavior/diet is progressing well, and all data are entered immediately into the wild sea otter database (WSOD). At this time the database includes over 12,000 re-sightings of study animals (recording location, reproductive status, etc.); approximately 6,000 records for activity budgets (behavior, location, body temperature); and over 27,000 observational records of feeding dives (dive success, prey type, dive location). Of the 72 study animals captured to-date, 9 are confirmed dead, 3 are missing and presumed to be dead, and the remainder are accounted for (Appendix 1). Of the animals captured at the outset of the project in 2001, at least 7 have transmitter radios that are confirmed or suspected to have failed, meaning that resight data from these animals are now collected only sporadically, and can no longer be used for survival/reproduction estimates. This was expected; however, as VHF transmitters of this type are known to be unreliable after two years of deployment.

As was the case during the first two years of the study, the majority of males captured in the southern study area have made regular long-distance movements of 100 - 400 km to locations throughout the range (Figure 1). In some cases these movements span the entire current range of the southern sea otter population. Study animals that were captured in the northern study area tend to make far fewer long-distance movements (Figure 1), although a slight increase in then frequency of long-distance movements was observed during the late winter months of 2003.

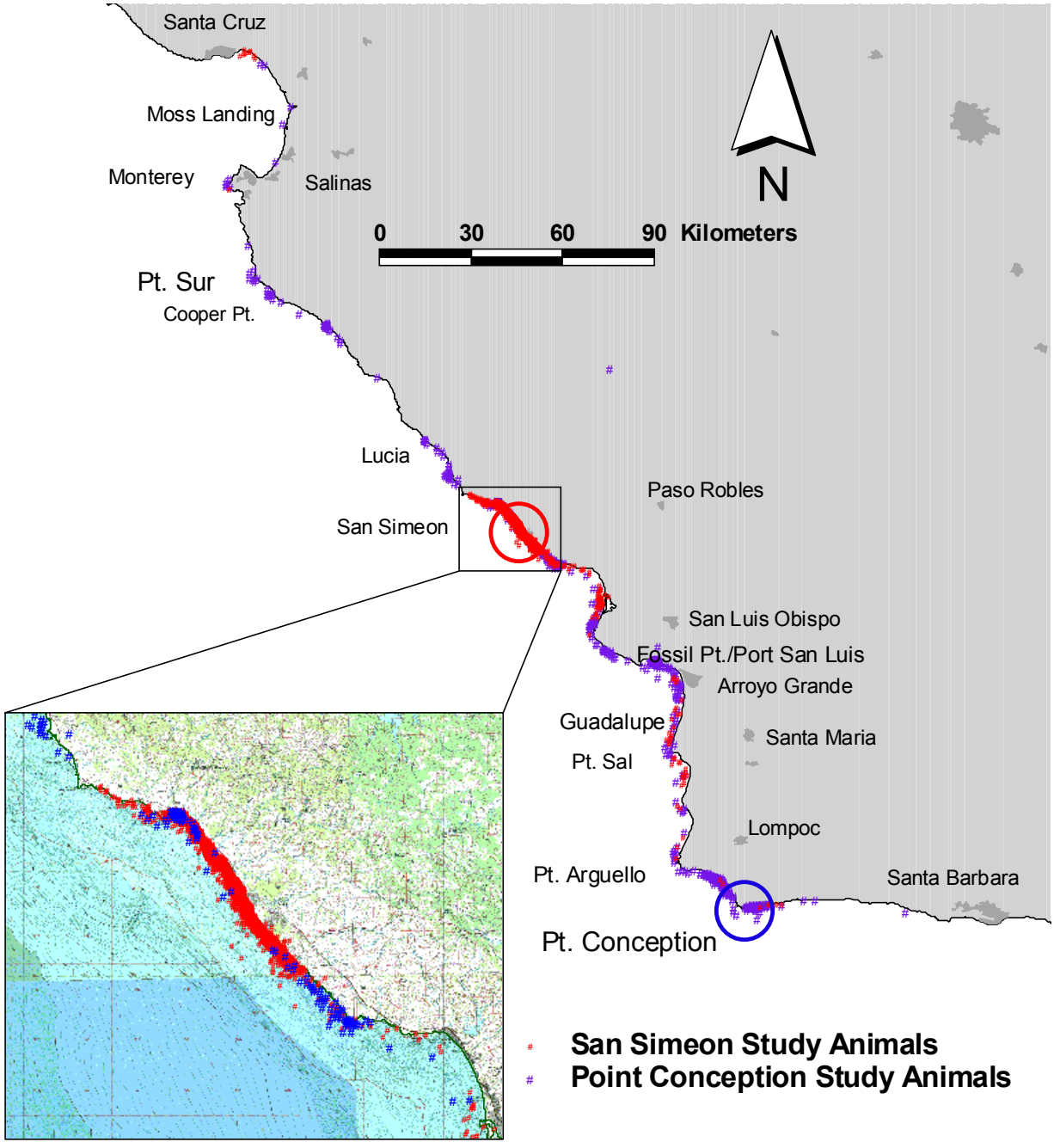


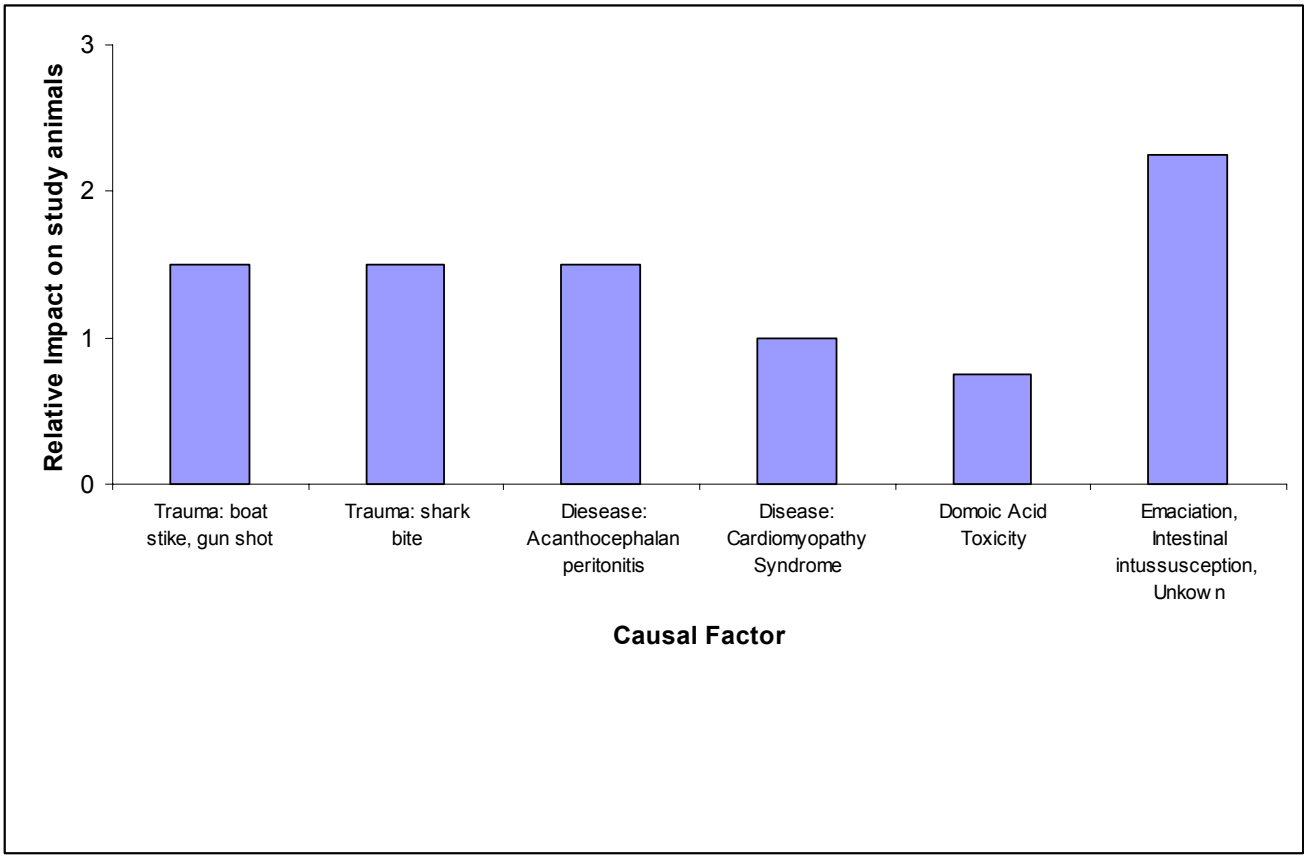
Figure 1. Map of Central California showing initial capture locations (large open circles) and subsequent re-sight locations (small filled circles) of animals from the San Simeon study site (colored red) and the Pt. Conception study site (colored blue). Insert map shows a blow-up of the intensive study area at San Simeon.

Necropsies have been conducted for 8 of the 9 confirmed mortalities: in the case of the 9th animal, a VHF radio transmitter was recovered with no carcass (this animal had been re-sighted alive only days before, so it is fairly safe to assume trauma as cause of death, possibly shark bite or boat strike). In addition to trauma, other factors associated with mortality of study animals include disease (particularly ancanthocephalan peritonitis and cardiomyopathy syndrome), intestinal intussusception, septic peritonitis and emaciation. One male that died near Pt. Conception (carcass # 3706-02) appears to have died from domoic acid toxicity; however a healed shotgun wound was also discovered during the necropsy. Table 1 summarizes both known and suspected causes of death for the 9 confirmed mortalities. Figure 2 shows the relative frequency (to-date) of each of 6 sources of mortality, based on data presented in Table 1.

Table 1. Summary of probable causal factors associated with death of 9 study animals. Black-filled boxes indicate confirmed causes of death, grey-filled boxes indicate probable causes and hatched boxes indicate secondary or possible contributing causes of death.

	Probable Causal Factors (including primary and secondary causes of death)					
Carcass #	Trauma: boat stike, gun shot	Trauma: shark bite	Diesease: Acanthocephalan peritonitis	Disease: Cardiomyopathy Syndrome	Domoic Acid Toxicity	Emaciation, Intestinal intussusception, Unkown
3529-01						
3544-01						
3614-01						
3706-02						
3769-02						
3776-02						
3784-02						
3810-02						
3819-02						

Figure 2. Relative frequency of occurrence of 6 sources of mortality, based on a tabulation of causes of death for 9 study animals. Confirmed causes of death are scored as 1, probable causes are scored as 0.75, and possible or secondary causes are scored as 0.25.



Appendix 1.A. Summary of capture date and current status (as of 04/03/03) of study animals captured during the past year of the study. Dead animals indicated with bold typeface.

Capture Date	BRD_NO	Sex	Last Observed	Status	# Resights
2002 Captures, San Simeon Study Area					
20-Mar-02	838-02	f	04-Apr-03	Alive, regularly resighted	337
20-Mar-02	839-02	f	04-Apr-03	Alive, regularly resighted	277
21-Mar-02	840-02	f	27-Aug-02	**Confirmed Mortality**	156
20-Mar-02	841-02	f	21-Mar-03	Alive, regularly resighted	596
21-Mar-02	842-02	m	31-Mar-03	Alive, regularly resighted	292
22-Mar-02	843-02	m	03-Apr-03	Alive, regularly resighted	170
21-Mar-02	844-02	f	04-Apr-03	Alive, regularly resighted	269
22-Mar-02	845-02	f	04-Apr-03	Alive, regularly resighted	282
22-Mar-02	846-02	f	04-Apr-03	Alive, regularly resighted	319
22-Mar-02	847-02	f	04-Apr-03	Alive, regularly resighted	290
25-Mar-02	848-02	m	25-Apr-02	**Confirmed Mortality**	16
22-Mar-02	849-02	m	10-Aug-02	**Confirmed Mortality**	30
22-Mar-02	850-02	f	04-Apr-03	Alive, regularly resighted	113
25-Mar-02	851-02	f	04-Apr-03	Alive, regularly resighted	321
25-Mar-02	854-02	f	04-Apr-03	Alive, regularly resighted	324
21-Mar-02	856-02	m	31-Mar-03	Alive, regularly resighted	20
08-Oct-02	867-02	F	05-Apr-03	Alive, regularly resighted	145
08-Oct-02	868-02	F	04-Apr-03	Alive, regularly resighted	120
08-Oct-02	870-02	F	31-Mar-03	Alive, regularly resighted	39
08-Oct-02	872-02	F	23-Dec-02	**Confirmed Mortality**	70
09-Oct-02	887-02	F	03-Apr-03	Alive, regularly resighted	142
08-Oct-02	888-02	M	31-Mar-03	Alive, regularly resighted	176
08-Oct-02	889-02	M	31-Mar-03	Alive, regularly resighted	23
09-Oct-02	890-02	F	04-Apr-03	Alive, regularly resighted	152
09-Oct-02	891-02	F	03-Apr-03	Alive, regularly resighted	120
09-Oct-02	892-02	F	31-Mar-03	Alive, regularly resighted	67
09-Oct-02	893-02	M	31-Mar-03	Alive, regularly resighted	56
09-Oct-02	894-02	M	31-Mar-03	Alive, regularly resighted	16
09-Oct-02	895-02	F	04-Apr-03	Alive, regularly resighted	155
09-Oct-02	896-02	F	03-Apr-03	Alive, regularly resighted	112
09-Oct-02	897-02	M	31-Mar-03	Alive, regularly resighted	44
10-Oct-02	898-02	F	04-Apr-03	Alive, regularly resighted	117
2002 Captures, Pt. Conception Study Area					
22-Apr-02	857-02	m	31-Mar-03	Alive, regularly resighted	19
22-Apr-02	860-02	m	04-Feb-03	Alive, regularly resighted	14
22-Apr-02	861-02	m	31-Mar-03	Alive, regularly resighted	21
24-Apr-02	862-02	m	31-Mar-03	Alive, regularly resighted	15
24-Apr-02	863-02	m	31-Mar-03	Alive, regularly resighted	16
24-Apr-02	864-02	m	31-Mar-03	Alive, regularly resighted	18
24-Apr-02	865-02	m	31-Mar-03	Alive, regularly resighted	18
25-Apr-02	866-02	m	31-Mar-03	Alive, regularly resighted	4
25-Apr-02	869-02	m	31-Mar-03	Alive, regularly resighted	6
22-Apr-02	871-02	m	31-Mar-03	Alive, regularly resighted	22
22-Apr-02	873-02	f	16-Feb-03	Alive, regularly resighted	15

Appendix 1.B. Summary of capture date and current status (as of 04/03/03) of study animals captured during previous years of the study. Dead animals indicated with bold typeface.

Capture Date	BRD_NO	Sex	Last Observed	Status	# Resights
2001 Captures, San Simeon Study Area					
24-Mar-01	787-01	f	09-Feb-03	Confirmed radio failure, resighted sporadically	551
24-Mar-01	788-01	f	04-Apr-03	Alive, regularly resighted	546
24-Mar-01	789-01	f	01-Mar-03	Confirmed radio failure, resighted sporadically	344
24-Mar-01	790-01	f	22-Mar-03	Confirmed radio failure, resighted sporadically	450
24-Mar-01	791-01	f	04-Apr-03	Alive, regularly resighted	441
25-Mar-01	796-01	f	08-Dec-02	Confirmed radio failure, resighted sporadically	480
11-Apr-01	800-01	f	10-Sep-02	**Confirmed Mortality**	423
25-Mar-01	797-01	f	04-Apr-01	**Missing Assumed dead**	4
24-Mar-01	792-01	f	10-Nov-01	**Confirmed Mortality**	158
25-Mar-01	799-01	f	24-May-01	**Confirmed Mortality**	21
12-Apr-01	801-01	f	11-Jul-01	**Confirmed Mortality**	47
12-Apr-01	803-01	f	20-Mar-03	Confirmed radio failure, resighted sporadically	600
12-Apr-01	804-01	m	31-Mar-03	Alive, regularly resighted	478
25-Mar-01	798-01	m	02-Jul-01	**Confirmed Mortality**	15
12-Apr-01	802-01	f	04-Apr-03	Alive, regularly resighted	365
2001 Captures, Pt. Conception Study Area					
08-May-01	805-01	m	31-Mar-03	Alive, regularly resighted	60
08-May-01	806-01	m	02-Dec-02	Missing, potential radio failure	45
08-May-01	807-01	m	16-Feb-03	Aerial Resights Sporadically	26
08-May-01	808-01	m	31-Mar-03	Alive, regularly resighted	39
08-May-01	809-01	m	31-Mar-03	Alive, regularly resighted	263
08-May-01	811-01	m	31-Mar-03	Alive, regularly resighted	32
09-May-01	812-01	m	16-Feb-03	Aerial Resights Sporadically	28
09-May-01	813-01	m	13-Nov-02	**Confirmed Mortality**	22
09-May-01	814-01	m	31-Mar-03	Alive, regularly resighted	42
09-May-01	815-01	m	04-Feb-03	Aerial Resights Sporadically	35
10-May-01	816-01	m	31-Mar-03	Alive, regularly resighted	56
10-May-01	817-01	m	16-Feb-03	Aerial Resights Sporadically	42
10-May-01	818-01	m	29-Jan-03	Missing, potential radio failure	27
09-May-01	820-01	m	24-May-02	**Missing Assumed dead**	13

Task No. 17606: *Population Genetics of surfgrass (Phyllospadix torreyi) for use in restoration*

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Summary of Research

The overall objective of our study is to characterize genetic factors that may affect the success of restoring surfgrass populations in Santa Barbara County. Our proposed work focuses on two major factors. The first is the spatial boundaries of genetically differentiated populations and the second is the spatial distribution of male and female plants within interbreeding populations. This information will enhance restoration efforts that aim to maintain current levels of genetic diversity. It will be valuable not only in practical aspects of restoration practice, such as the choice of material for restoration, but it will also greatly increase our understanding of processes by which surfgrass stands are maintained and restored in nature.

Our study has three specific objectives:

1. To identify the boundaries of genetically differentiated surfgrass populations.
2. To determine if there is genetic differentiation within populations with respect to clone size and depth.
3. To develop genetic markers linked to gender and characterize the spatial distribution of male and female plants within surfgrass populations.

Progress during 2002-2003

In this second, and final year of our study, we have completed work on all three of these objective. Briefly, our findings show:

1. Evidence for moderately strong genetic differentiation of surfgrass populations between the three regions of our study area (Table 1).
2. Evidence of genetic differentiation within single populations between individuals growing at shallow depths (intertidal) and those growing in deeper water (subtidal). This genetic differentiation is remarkable because of the high level of genetic variation we found within individual populations (Table 1).
3. Evidence for unique, male-specific genetic markers which show that surfgrass populations have a pronounced female-biased sex ratio (Tables 2 and 3).

These data will impact restoration efforts insofar as they indicate that plants or seedlings used in restoration should come from local populations, and should be genetically highly diverse. Finally, they indicate that since males are rare in natural populations but are found throughout surfgrass beds, special efforts may not be required to identify male plants in the material used for restoration, provided that material contains some males.

Progress and findings for Goal 1. To identify the boundaries of genetically differentiated surfgrass populations.

During the last year, we completed the quantification (i.e. "scoring") of DNA-fingerprints from AFLP analysis of 603 individual surfgrass samples. These samples represent individual collections from 21 sites along the Santa Barbara coast from Purisima Point to Rincon. The precise location of these sample sites are documented in our first annual report. Briefly, however, the sample sites cluster into 3 regions that are separated by approximately 40 km. The first, northernmost, region extends from Purisima Point to Point Arguello, the second extends from San Augustine to Trajiguas, and the third extends from Arroyo Burro to Rincon. Within each of these regions, population samples were collected at 7 separate sites. This sampling strategy allows us to quantify genetic variation over a large range of spatial scale from a few meters (within individual populations) to more than 100 km (between regions).

DNA-fingerprinting with AFLPs has generated over 600 genetic markers for each individual. An analysis of these markers indicates that 62% of the genetic variation found in surfgrass occurs within individual populations (see column "Overall" of Table 1 on the following page). This reflects a high degree of genetic diversity within individual populations. Nevertheless, a relatively large fraction of the genetic variation occurs between populations (18%, Table1) and among the regions (20%, Table1). These data indicate that genetic differentiation does occur over short distances that separate individual populations. They also show that genetic diversity within populations is very high.

Progress and findings for Goal 2: To determine if there is genetic differentiation within populations with respect to clone size and depth.

During the last year, we performed an analysis of AFLP fingerprints for approximately 100 surfgrass samples growing at subtidal depths in order to determine if genetic differentiation occurred across the depth gradient within individual populations. For this purpose, we sampled 10 individuals at each of 9 sites from which we had previously collected in the intertidal. The individual sites were as follows:

Region 1 (Purisima Point to Point Arguello): Site 4, Lompoc Landing, and Boat House.
Region 2 (San Augustine to Trajiguas): Caliente, Arroyo Quemado, and San Onofre.
Region 3 (Arroyo Burro to Rincon): Hendry's, Leadbetter, and Miramar.

DNA-fingerprints have been scored for all of the subtidal samples and analysis of this data shows that 14% of the genetic variation within populations can be attributed to differences in depth (Table 1, Depth). This reflects a high degree of partitioning of variation within populations and could reflect specialization to different habitats within populations.

Table 1. Analysis of molecular variance (AMOVA) for *Phyllospadix torreyi* (surfgrass) along the Santa Barbara coast of California. Analysis were performed using approximately 600 variable genetic markers. Overall genetic variation (Overall) was analyzed for 603 individuals representing 21 separate populations that cluster in three regions. Genetic variation due to intertidal or subtidal location (Depth) was analyzed for 9 populations where samples were collected in both the intertidal and subtial.

Genetic Variation in Surfgrass (%)			
Overall		Depth	
Among Regions	20	Among Populations	20
Among Populations within Regions	18	Intertidal/ Subtidal within Populations	14
Within Populations	62	Within Populations	66

In order to determine if clone size differed with depth, we also performed AFLP analysis of samples collected from the subtidal and intertidal along transects at each of two sites. These sites, Alegria (in Region 2) and at Shorline (in Region 3), were chosen to represent sites with high wave-action (Alegria) and those that are relatively calm (Shoreline). Clone size does appear to differ at these two sites. Clones were detected up to 10 m apart at Shorline but not more that 6 m apart at Alegria. Perhaps the most significant finding from this study is not that clones size is slightly larger in calm areas, but that most clones are very limited in size. This directly contradicts that widely held notion that surfgrass is largely clonal.

Progress and findings for Goal 3. To develop genetic markers linked to gender and characterize the spatial distribution of male and female plants within surfgrass populations.

Because the sexes are separate in surfgrass (plants produce either male or female flowers) it is important for restoration efforts to determine the frequency and spatial distribution of the sexes in natural populations. Currently, male and female plants can only be distinguished by their flowers. In order to develop a more robust assay for gender, we have looked for AFLP-markers that are correlated with gender. During the last year, we have cloned and sequenced 13 male-specific markers.

Table 2. Characterization of male-specific AFLP markers in P. torreyi. The oligonucleotides used to generate the AFLP bands that are associated with maleness (AFLP Primers) and the size of the marker in basepairs (Size) is given. Homologues identified by a search of the NCBI database using the protein translation of the marker DNA sequence are shown (Homologues).Only the most significant homologues, if any, are shown.

Male-Marker Number	AFLP Primers	Size[1]	Homologues
1	M-CTG, E-ACT	161	None
2	M-CTT , E-ACA	124	None; 98% Identical to Band 3
3	M-CAT, E-ACA	125	None
4	M-CTC, E-AAC	218	None
5	M-CTC, E-AAG	376	Pol Polyprotein Reverse Transcriptase
6	M-CTC, E-AAG	835	Pol Polyprotein Retrotransposon
7	M-CAA, E-AAC	176	None
8	M-CCA, E-AAG	655	Pol Polyprotein Retroelement
9	M-CAG, E-AAG	513	Pol Polyprotein Retroelement
10	M-CCC, E-AAC	270	None

[1] Size includes the AFLP primers which add a total of 38 bp to the native sequence.

Using these markers, we have examined the collections made for the first two parts of our study (approximately 600 samples) and found the overall frequency of males to be 3 to 10%. In contrast to what has been previously reported the distribution of males, we found no evidence that males are more common in deeper waters, instead, we found males are equally rare everywhere.

Table 3. Number and frequency of P. torreyi. males in three regions of the Southern Coast of California.

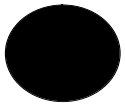
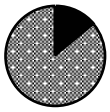
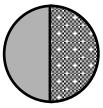
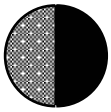
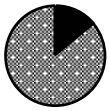
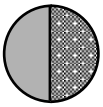
	Region1[1]	Region 2 Number (%)	Region 3
Total Samples	157	219	218
Total Genotypes[2]	123	193	166
Total males (%)[3]	3 (2.4)	8 (4.1)	10 (6.0)
Intertidal Samples	133	164	163
Intertidal Genotypes	99	139	109
Intertidal males (%)	3 (2.2)	8 (5.7)	6 (5.5)
Subtidal Samples	20	55	55
Subtidal Genotypes	20	51	51
Subtidal males (%)	0 (0)	1 (1.9)	4 (7.8)

[1] Sampling Sites are those listed in the Popualation column of Table 1.
[2] The number of unique genotypes in the sample population. Samples were considered to be the same genotype if they differed in 5% or less of the AFLP bands. Approximately 450 AFLP bands were scored.
[3] The percentage is based on the number of genotypes. Percentages based on the number of samples will lower. Chi-sqaure test show no significant difference in the frequency of males among regions or between the subtidal and intertidal.

Summary of progress

The work described in our proposal consists of three distinct phases: Field work (sample collection), Laboratory work (DNA isolation and AFLP-fingerprint construction), and Data Analysis (band scoring and statistical analysis). We have completed all aspects of the work we proposed to do. The progress of our work is shown in Table 4. Work completed in the first 6 months (the time of our first annual report) is shown in black, work completed in the next year (second annual report) is shown as gray pattern. Work completed in this last year is shown in solid gray.

Table 4. Fraction of work completed.

Specific Goal	Field Work	Laboratory Work	Data Analysis
1. Population Boundaries			
2. Variation with Depth and Clone Size			
3. Gender markers			

Publications

There have been no publications during this period. We are currently preparing two manuscripts that describe our work.

Research Presentations

This work was presented at a conference on “Sex Specific Markers” at LaSage Switzerland in Summer 2002.

Task No. 17607: *Public Perceptions of Risk Associated with Offshore Oil Development*

Principal Investigators: Eric R.A.N. Smith, Department of Political Science, University of California, Santa Barbara, CA 93106-9420

Project Objectives

The goal of this project is to design a set of public opinion surveys and news media content analysis methods in preparation for a time series analysis of NIMBY responses to proposed offshore oil development projects along the Santa Barbara coast in California. Current oil-lease holders are considering a number of new drilling projects. This project will prepare a set of methods to study the public's reaction to the debate surrounding these proposed projects.

Summary of Research

Whenever a neighborhood or community group objects to a local development, someone suggests that the objections are part of a NIMBY, or "Not in My Backyard" pattern of responses. NIMBY behavior has been responsible for slowing or blocking a wide variety of government and industry proposals—including offshore oil developments. In some cases, such as housing developments, NIMBY resistance is motivated by people's preferences about the quality of life in their communities. In other cases, NIMBY resistance is motivated by people's perceptions of risks associated with the developments. In some of these cases, critics allege, the fears are irrational because they are based on misinformation. That is, people are said to fear hazards that have extremely small probabilities of occurring. Offshore oil development is one area in which exaggerated perceptions of risks may influence public opinion, and therefore government and industry decisions.

Despite the prominent role of NIMBY influence on many government and industry decisions, researchers have not yet developed a full understanding of it. Although there is a substantial literature on risk perceptions, relatively little of it examines risk perceptions in the context of actual NIMBY behavior, and none it has examined the development of a NIMBY response over an extended period of time. That is, no investigator has yet used a series of public opinion surveys to explore how people's knowledge, risk perceptions, policy preferences, and behavior change over time during the course of a public debate about proposed development such as a new offshore oil platform. This study is developing a research design to do just that.

The core of the design will be a series of public opinion surveys extending for a period of five years so that we can measure change over time. A baseline survey—the 1998 Offshore Oil Drilling and Energy Policy Survey, funded by the University of California's Toxic Substances Research and Teaching Program—has already been conducted. Subsequent surveys will measure the public's knowledge of oil development in general and the proposed projects in particular, as well as the public's perceptions of various risks associated with the projects, including both risks to people and to the environment. In addition, the surveys will measure people's preferences about the projects and the extent to which they act on their preferences by writing letters, attending meetings, and engaging in other forms of political activity. Finally, the surveys will measure a variety of variables that various theories suggest may explain people's knowledge, perceptions of risk, preferences, and activism.

In order to explain the public's response to the drilling project, we will also study the sources from which the public receives information or persuasive communications—that is, the news media, industry advocates, and political activists. These efforts will include a content analysis study of local newspapers, television news, and radio as well as an effort to obtain and analyze any direct mail or other communications from the oil industry or advocates on either side of the conflict. Measuring these communications will allow us to test theories explaining changes in the public's knowledge, opinions, and behavior over time.

Progress during 2002-2003

People misperceive the risks they face from potential environmental hazards. They exaggerate the statistical odds of some potential causes of injury or death, while they underestimate others. The goal of this project is to use public opinion survey data and news media content analysis to explain people's perceptions of the risks associated with offshore oil and gas development. The specific products of this project will be a series of papers analyzing various surveys of Californians' knowledge of and attitudes toward offshore oil and gas development, and a design for a two-wave, panel-design survey to measure changes in risk perceptions and their causes.

A key assumption of this project is that people's risk perceptions and attitudes toward environmental issues such as oil development are largely determined by their basic worldviews and values, not by their factual knowledge regarding oil development. To explore this hypothesis, we analyzed a 1998 survey of Californians. We found that party identification, ideology, and the values of egalitarianism and individualism explain people's attitudes toward oil development fairly well, while an index measuring postmaterialist values did not work well at all. In addition, we found that basic demographic variables (e.g., age, education, income, and gender) had almost no explanatory power. These results, which support our approach to explaining risk perceptions, are reported in "Postmaterialism vs. Cultural Theory as an Explanation of Environmental Opinion."

In addition to examining attitudes toward oil develop and the associated risks, we also examined the public's trust in the oil industry, in government officials regulating the oil industry, and in their environmental group critics. Trust is a key variable in both risk perceptions and support for oil development. People who do not trust the oil industry and its government regulators will be likely to exaggerate the risks associated with offshore oil development, and to oppose further development. Using a 2002 survey of Californians, we found that the public has a low level of trust in both the oil industry and its government regulators (the U.S. Minerals Management Service); in contrast, the public trusts environmental groups far more (20 points more on a 0-100 scale). This picture of distrust changes somewhat when we distinguish local and national government regulators. Local Interior Department staff is trusted substantially more than Washington staff. Fifty-three percent of the respondents said they had a "great deal" or "moderate amount" of confidence in local staff, but only 34 percent said they had a similar amount of confidence in the Interior Department's Washington staff.

We also used multivariate methods to model trust as a function of basic values (party identification, ideology, egalitarianism, individualism,) and political awareness, using the approach mapped out by John Zaller in *The Nature and Origins of Mass Opinion*. Although we could not investigate the dynamic way in which distrust builds over time as energy prices rise (because we did not use panel surveys), we could explore the basic causes of trust. We found,

once again, that basic values explain trust fairly well. The results about trust are reported in "Trust during an Energy Crisis."

Finally, using a series of surveys conducted from 1977 through 2001, we examined changes in support for offshore oil and gas development over time. We found evidence showing that people's support for drilling depends on both basic values and on the current price of gasoline at the pump. When gasoline prices surged upward, public support for drilling increased from 20 percent in 1998 to 45 percent in 2001. Three groups accounted for most of the surge of support for oil development—Republicans, conservatives, and low-income people. While support among strong Democrats increased only eight percent during the 1998-2001 period, support among strong Republicans increased 42 percent. Liberals and conservative responded similarly. A related pattern occurred with income. In 1998, people at all income levels were about equally likely to support more oil drilling. When prices rose, however, people with incomes under $20,000 per year increased their support by 38 percent, while people with higher incomes increased their support from 18 to 24 percent. Those who were hurt most by the increased prices responded most strongly in favor of more energy development. These results are reported in "Support for Offshore Oil and Gas Drilling among the California Public."

During the past year, we also collected a set of content analysis measures from California newspapers. We will be using those data, along with gasoline price data and survey data to explain changes in public support for oil development over time.

Problems Encountered

None

MMS Action Required

None

Future Plans

Completing the time-series analysis using the news-media-content data together with other data to explain changes in attitudes toward oil development over time, and competing additional analyses of the public opinion survey data.

Task No. 17608: *Observing the Surface Circulation along the South-Central California Coast Using High Frequency Radar: Consequences for Larval and Pollutant Dispersal* and
Task No. 85386: *Observations of the surface circulation in the Eastern Santa Barbara Channel using high frequency radar and Lagrangian drifters*

Principal Investigators: Libe Washburn, Department of Geography, University of California, Santa Barbara, CA 93106-4060 and **Steven Gaines,** Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, CA 93106-9610

Summary of Research

Progress during 2002-2003

Over the past year we made significant progress in our MMS funded research. We have installed a new radar system in the eastern Santa Barbara Channel to observe the regional surface circulation. In collaboration with Dr. Carter Ohlmann we are combining observations from our high frequency (HF) radar array with drifter observations to test the capability of extracting water parcel trajectories from radar data. Dr. Leo Oey, an MMS-funded scientist at Princeton University, is collaborating with us to assimilate surface current from the HF radars into his numerical models of the regional circulation. Mr. Edwin Beckenbach, a Ph.D. candidate at UCSB working on this research, has made substantial progress over the past year. He has completed his analysis of wave-like phenomena in the western Santa Barbara Channel and is about to submit a manuscript describing his results. Analysis of a large interdisciplinary data set collected during the summer and fall of 2001 shows that physical processes such as internal waves and bores appear not to be important transport mechanisms along the mainland coast in the northern part of the Southern California Bight. This finding suggests that new mechanisms must be considered to understand delivery of marine organisms to regional intertidal habitats. We continue to operate an array of HF radars in the Santa Barbara Channel and on the central California coast. We are also working on establishing new sites in the eastern Santa Barbara Channel.

1. Regional circulation

1.1 Topographic waves in the Santa Barbara Channel

Our analysis and synthesis of propagating wave-like features in the western Santa Barbara Channel is now complete. A three-year record of high frequency (HF) radar observations of surface currents in the western Santa Barbara Channel (SBC) reveals sequences of alternating of cyclonic and anticyclonic vortices propagating westward with a period of about two weeks. The sequences last up to a few months and occur intermittently throughout the year. The surface velocity distribution of cyclones and anticyclones are anti-symmetric with typical relative vorticity magnitudes on the order of 0.1 f, where f is the local Coriolis parameter. These propagating vortices resemble the propagating cyclones in the 10-25 day pass-band reported in the Santa Barbara Channel by [Harms and Winant, 1998]. The propagation speed (5 km day^{-1}) and period (14.3 ± 2.0 days) are consistent with an analytical model describing fundamental (lowest mode) topographic Rossby modes in a closed basin with the dimensions of the Santa Barbara Basin. Peak relative vorticities over the basin are about a factor of four higher than those over the edges, indicating topographic control. The discovery of these waves is important because they strong produce strong offshore and onshore flows persisting for several days which

can transport larvae or pollutants either toward or away from the coast depending on which parts of the wave are present. The waves are triggered by other larger-scale coastal trapped waves traveling poleward along the mainland coast. These results are described in a manuscript about to be submitted for publication to the Journal of Geophysical Research [*Beckenbach and Washburn*, 2003]. The results were also presented at the 2002 Ocean Sciences Meeting in Honolulu [*Beckenbach and Washburn*, 2002]. Mr. Beckenbach is also using HF radar observations to test model predictions of [*Oey et al.*, 2001] for the flow in the Santa Barbara Channel under different conditions of wind forcing.

1.2 Regional and near shore circulation processes

We are collaborating with Dr. Carter Ohlmann, an MMS-funded investigator at UCSB, to explore transport pathways over the inner shelf region. This is an important issue because the inner shelf must be crossed by organisms and pollutants to reach the coastline. Presently flow processes over the inner shelf are poorly understood. One approach we are adopting is to determine flow pathways over the inner shelf using a new drifter, called a Microstar™ (manufactured by the Pacific Gyre Corporation of Carlsbad, CA) which is small, lightweight, and easily deployed from small boats. Its position is tracked by GPS so trajectories are very accurate. Microstar drifters are released at various locations offshore and trajectories are measured over periods ranging from several hours to a few days. When the drifters are in the coverage areas of the HF radars, the larger scale current features within which the drifters are moving can be identified.

We are also working on modeling approaches for using HF radar observations to best predict surface water parcel trajectories. This is an important task since we hope ultimately to develop the capability to predict the transport and dispersion of marine pollutants such as oil and contaminated stormwater runoff. Preliminary results suggest that inner shelf flows vary strongly over spatial scales of a few to several hundred meters. The limited temporal and spatial resolution of HF radars may not be adequate to observe the rapidly evolving small scale velocity structures which govern the fluid trajectories over the inner shelf. Our approach to this difficulty is to incorporate a stochastic velocity component in the HF radar analysis as is often done in trajectory modeling (e.g. [Mariano et al., 2002; Sawford, 1985]). Drifters are being released in a variety of conditions such that trajectories can be examined under the various flow states which have been identified in the Santa Barbara Channel, such as recently described by [*Winant et al.*, 2003].

Over the past year we began collaboration with Dr. Leo Oey of Princeton University to combine HF radar observations of surface currents with his numerical modeling of the regional circulation. A goal of the collaboration will be to test the models ability to predict circulation patterns in regions where measurements were previously unavailable such as the center of the western Santa Barbara Channel. In the numerical model, current data from moorings deployed by the Center for Coastal Studies at the Scripps Institution of Oceanography are assimilated to improve model predictions. Results from the assimilation are being compared to surface current measurements over some 1400 km^2 of the western Channel obtained by the radars. This work has only recently begun so results are not yet available.

1.3 Regional circulation and larval settlement

During summer and fall of 2001 we conducted an intensive interdisciplinary field experiment to link settlement time series to oceanographic transport processes. For six months the settlement

of several invertebrate species was measured every other day. Settlement rates were determined by counting organisms which had settled onto artificial substrates suspended from a pier at Ellwood, CA. This sampling was a major effort because the settling organisms are very small which required identification of individual larvae using microscopes. To measure the flow field near shore and extensive suite of oceanographic instrumentation was deployed including acoustic Doppler current profilers (ADCP's), thermistor strings, and moored conductivity-temperature-depth (CTD) loggers. The results showed that settlement was generally low over the six month experiment period although there were several strong events. An interesting finding of the study was these settlement events were not clearly linked to organized flow features, such as internal waves and bores, as has been found in other areas of the Southern California Bight. This suggests that new and perhaps more chaotic transport mechanisms such as turbulence or sub-mesoscale eddies may be responsible. Near shore HF radar observations hint at the existence of eddy-like features near the site which evolve over time scales of a few days and produce onshore flow. In our ongoing analysis we are working to describe these features in more detail.

2. Status of the HF radar array

We are currently operating four HF radars on the central California coast and in the Santa Barbara Channel. The radars are located at the following sites: 1) Fallback 22 near Pt. Sal; 2) Refugio State Beach; 3) Coal Oil Point near Santa Barbara; and 4) Oxnard.

Several events occurred over the past year which affected our deployment of radars along the central California coast. One was an incident at Pt. Conception, CA in December 2001 in which a helicopter transporting members of our research group was damaged after landing. This incident led to the loss of our use agreement with the US Coast Guard so the radars at Pt. Conception and Pt. Arguello were removed. Fortunately nobody was injured during the incident and a multi-year data set describing the detailed flow structure around Pt. Conception was successfully collected. The site at Point Conception had always been problematic due to the lack of land access to the site since it required crossing the Bixby Ranch.

One of the radars removed from the Pt. Arguello and Pt. Conception sites has since been re-installed at the Mandalay Generating Station near Oxnard, CA. This is a significant development for the project since it will allow us to begin observing circulation processes in the eastern Santa Barbara Channel. We are working to establish a second site in the eastern Channel to extend the coverage in that region. At present we have coverage offshore in the eastern Channel in a region where the patterns of the Coal Oil Point and Mandalay radars overlap.

We are working to identify a location and obtain the necessary permits to establish a second site in the eastern Channel. We had hoped to establish a site on the Rincon Island near Mussel Shoals, CA, but after recent discussions with the new leaseholder of the Island, Greka Energy, we find that this site will likely be unavailable. We are currently exploring the region for other possible site locations. One lesson learned from this whole process is that obtaining permission from the various agencies, private companies, or other organizations is an extremely time consuming, costly undertaking. The processes moves very slowly and involves extensive technical paperwork. We now work with an environmental consultant to expedite this process. We hope in the future that procedures can be developed to streamline the overall permit process. This will facilitate ongoing initiatives aimed at establishing an ocean observing system off the

US west coast. Despite the difficulties we are confident that new sites will be located and the permit issues will be successfully resolved.

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Task No. 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, University of California, Santa Barbara, CA 93106-9610 **Jenifer Dugan,** Marine Science Institute, University of California, Santa Barbara, CA 93106-6150 **Scott Hodges,** Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, CA 93106-9610 **Robert Jacobs,** Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, CA 93106-9610 **Mark Page,** Marine Science Institute, University of California, Santa Barbara, CA 93106-6150 **Leslie Wilson,** Department of Molecular, Cellular and Developmental Biology, University of California, Santa Barbara, CA 93106-9610 and **Steven Gaines,** Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, CA 93106-9610

ECOLOGY:

Background

Interest in marine natural products continues to grow worldwide. However, concern over the impact of the harvest of organisms that contain these products on the environment has arisen because large quantities of organisms are typically needed to extract a small amount of a natural product. Harvest of organisms from man-made structures, particularly oil and gas platforms, may alleviate impacts to natural reefs as many species of invertebrates grow on these artificial structures. To determine the feasibility of using OCS oil platforms as sustainable sources of, or as culturing sites for, invertebrates with important marine natural products, we are investigating the distribution, abundance and population dynamics of marine invertebrates at seven oil platforms in the Santa Barbara Channel. Specifically, we are: 1) investigating spatial and temporal patterns in the distribution and abundance of invertebrates at the platforms, 2) exploring whether the population dynamics (recruitment and growth) of selected invertebrates vary among platforms (both spatially and temporally) and 3) examining the relationship between the patterns found at the platforms and oceanographic gradients (location, water temperature) in the Santa Barbara Channel. Results from our field experiments, which compared patterns of invertebrate recruitment and growth among platforms were highlighted in previous reports. Herein, we discuss the relationship between these patterns and oceanographic factors. In addition, we examine the distribution and abundance of selected invertebrates and patterns in existing communities, as analyzed from photographic surveys at our study platforms.

Study Sites

We conducted our research at seven oil and gas platforms in the Santa Barbara Channel (Table 1, Fig. 1). The platforms are arranged along the channel from the southeast to northwest in a region characterized by strong environmental and biogeographic gradients.

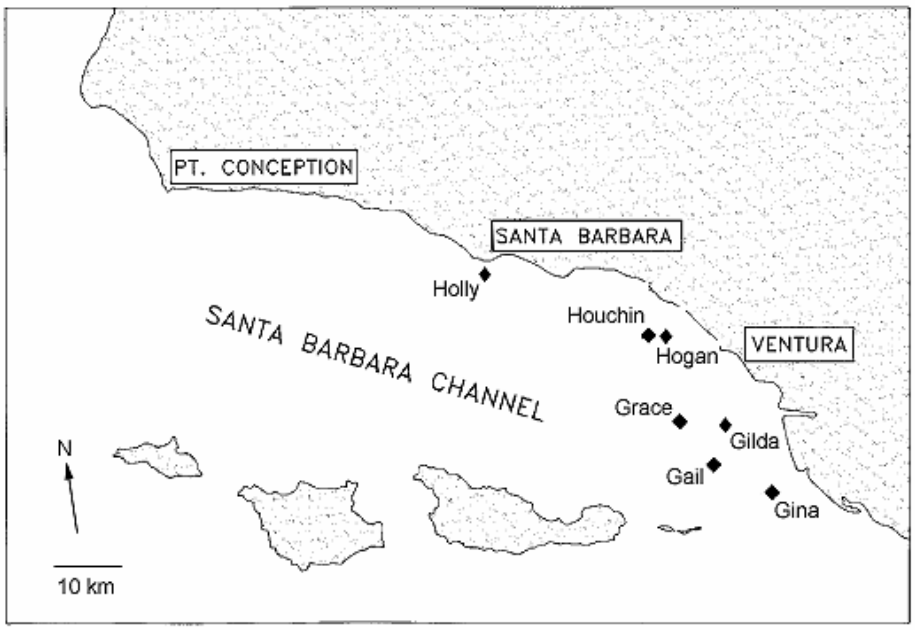


Figure 1. Locations of oil platforms in the Santa Barbara Channel involved in this study.

Table 1. List of platform study sites in the Santa Barbara Channel.

Platform	Location along coast (SE to NW) (km)	Coordinates
Gina	0	34° 11.72', 119° 27.60'
Gail	11.4	34° 12.50', 119° 40.02'
Gilda	15.0	34° 18.22', 119° 41.85'
Grace	19.0	34° 17.97', 119° 46.80'
Hogan	34.7	34° 33.75', 119° 54.38'
Houchin	35.1	34° 33.50', 119° 55.22'
Holly	65.4	34° 33.90', 119° 90.52'

Summary of Research

Progress during 2002-2003

Spatial variation in platform invertebrate communities

We explored spatial variation in patterns of invertebrate distribution and abundance within and among platforms along the Santa Barbara Channel by photographically sampling the invertebrate community. The camera (Nikonos V 35 mm camera fitted with a 15 mm lens) and two strobes were mounted on a PVC frame designed to photograph 0.25 m^2 quadrats. The distribution and abundance of species was measured by photographing a single quadrat located inside and outside

of the 4 corner legs and 4 randomly selected conductor pipes at depths of 6, 9, 18, and 24 m. A total of 128 quadrats were photographed per platform.

In the laboratory, we identified and estimated the percent cover of species within each photoquadrat using point-contact methods. Percent cover of species was estimated by projecting the photographic slide images onto 100 randomly located points and recording contacts to the lowest possible taxonomic level. For the purposes of this study, only the top layer was counted, except in the cases where a species obviously spread over the substratum, forming a "canopy", typical of some arborescent bryozoans and hydroids. Cover of nonliving substrata (e.g., bare pipe) was also recorded.

Distribution and abundance of selected taxa

There were dramatic differences among platforms in the distribution and abundance of several invertebrate taxa. For example, the strawberry anemone, *Corynactis californicus*, was abundant at the most southeasterly platform (Gina), but decreased in abundance on platforms to the northwest (Fig. 2). In contrast, the white anemone, *Metridium senile*, increased in abundance from Platforms Gina to Holly and was most abundant in deeper water at Holly (Fig. 2). The introduced encrusting bryozoan, *Watersipora cucullata*, was found only at Platform Gilda and was most abundant at depths of <20 m. Tubiculous amphipods (e.g., *Erichonius* sp.) were most abundant at the three northerly platforms (Hogan, Houchin, Holly).

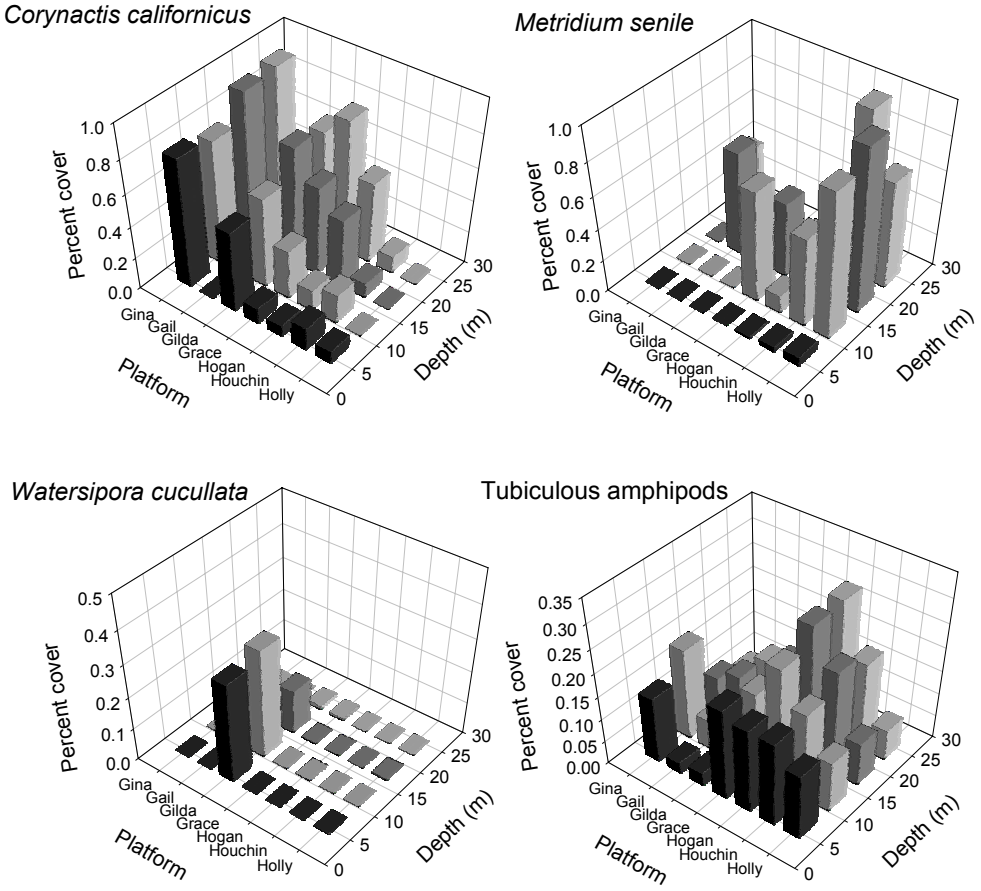


Figure 2. Comparison of the distribution and abundance of four taxa, the anemones, *Corynactis californicus* and *Metridium senile*, the encrusting bryozoan, *Watersipora cucullata*, and tubiculous amphipods, among study platforms and depths.

Community patterns

We are using multivariate techniques to explore variation in community patterns among platforms. Preliminary analysis shows that, with the exception of Platform Gail, platform communities vary along a gradient from Gina and Gilda in the southeast to Houchin and Holly in the northwest. Sources of variation in platform communities are still under investigation, but include the presence of introduced species at some platforms, such as *Watersipora cucullata* at Platform Gilda and an "orange anemone" at Gail (possibly *Diadumene* sp.), and the inverse distribution of some species such as the anemones *Corynactis californicus* and *Metridium senile*.

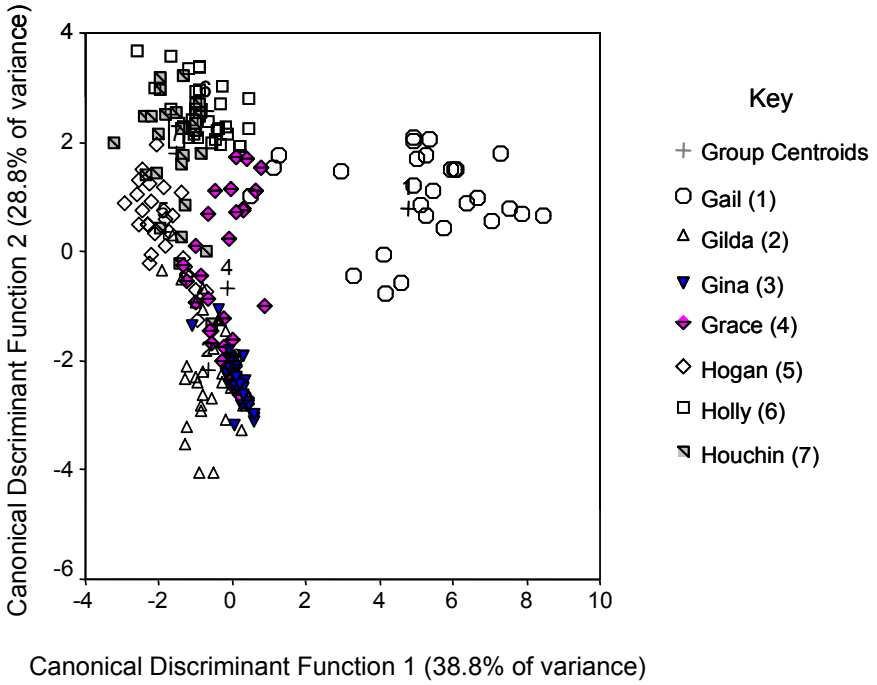


Figure 3. Results of Canonical Discriminant Function Analysis of invertebrate communities on the seven study platforms.

Measurements of water temperature during deployment of experimental modules

The prevailing gradient in oceanographic conditions in the Santa Barbara Channel is evident in satellite images showing the intrusion of warm water into the channel from the south and cold water from the west. To examine variation in water temperature among platforms, which could help to explain variation in community patterns, a HOBO temperature logger was attached to one of the experimental modules at each platform. Water temperature was recorded hourly, with the loggers retrieved and downloaded at the end of each experimental period. To compare temperatures among sites we calculated the frequency of the number of hours at each water temperature (Fig. 4).

Overall, the water temperatures at the three northern platforms were similar to each other throughout the year. Likewise, water temperatures of the four southern platforms were similar during all seasons, except in the summer. During the summer, one site (Gina) experienced large daily fluctuations in water temperatures, resulting in a broad range of temperatures throughout this season (Fig. 4). Such large temperature ranges were not recorded at the other southern sites.

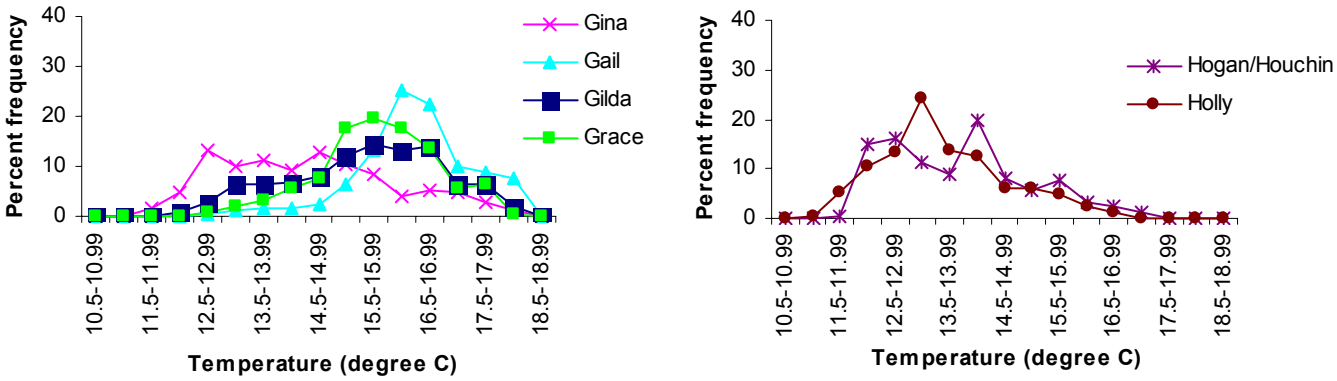


Figure 4. Water temperature frequencies by degree hours for Summer 2001 at a) southern and b) northern platforms.

Recruitment Patterns and Oceanographic Factors

As highlighted in our previous reports, there were significant spatial and temporal differences in patterns of recruitment of several taxa, although to varying degrees (Fig. 5). For example, for some species, recruitment was higher at the southern platforms (barnacles; *Balanus trigonus* and *B. regalis*), while for others recruitment was higher at the northern platforms (hydroids; *Plumularia* sp.). Further, for some species recruitment was spatially limited to just one (encrusting bryozoans; *Watersipora cucullata*) or two platforms (tunicates; *Diplosoma literianum*). Likewise, temporal patterns of recruitment varied among taxa, with recruitment of some species occurring seasonally while for others it was more continuous (e.g., tunicates).

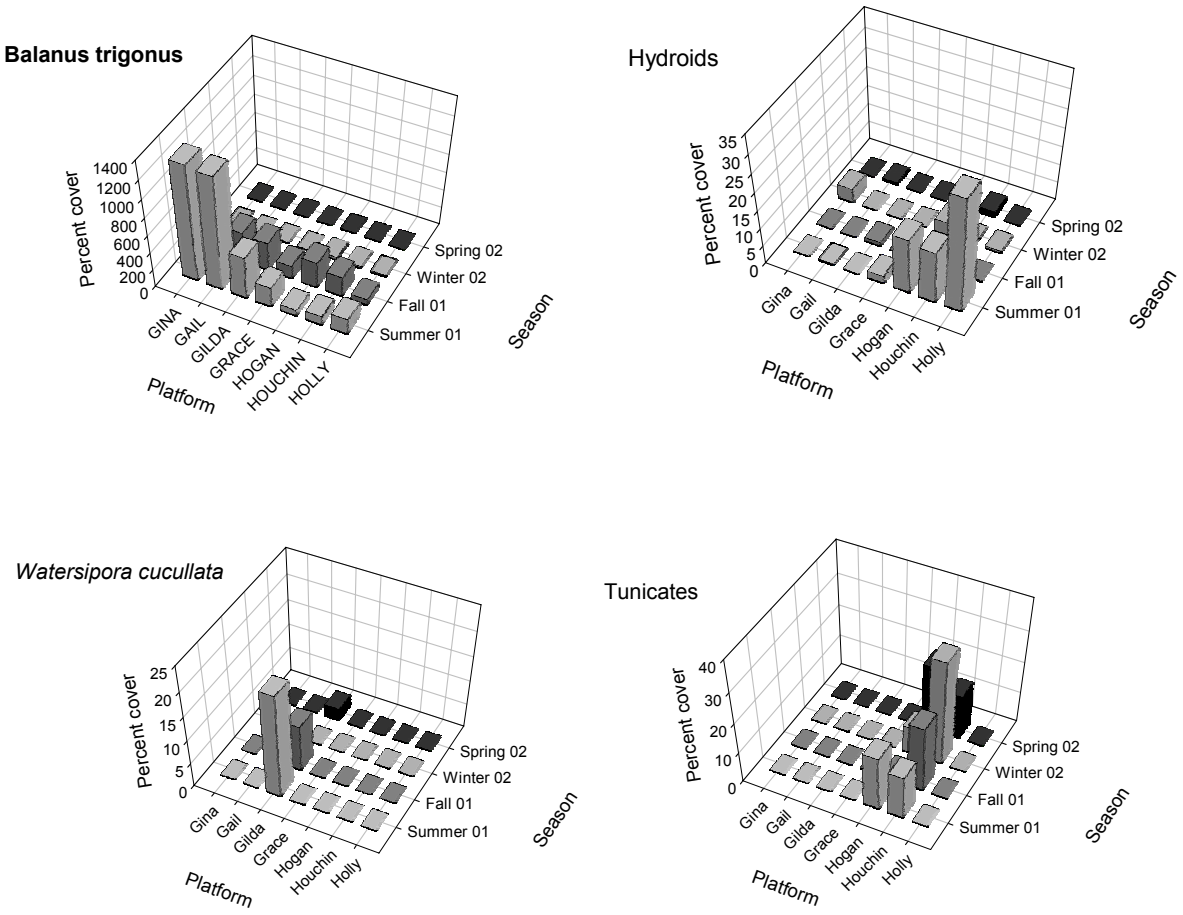


Figure 5. Comparison of spatial and temporal patterns of recruitment of four taxa, the barnacles, *Balanus trigonus*, the hydroids, *Plumularia* sp., the encrusting bryozoans, *Watersipora cucullata* and the tunicates, *Diplosoma* listerianum, among study platforms.

We used the nonparametric Spearman's Rho (Rs) to explore relationships between patterns of recruitment of selected invertebrates onto plates at the study platforms and location in the Santa Barbara Channel, platform depth, distance from shore and oceanographic factors (Table 2). For the three barnacle species, there was a significant effect of location, with higher recruitment densities occurring at the southern compared to the northern platforms. This pattern was consistent with predictions of oceanographic conditions bringing warm water masses and the longer-lived planktonic larvae of southern taxa into the channel. Recruitment density was also associated with location along the channel for the hydroid, *Plumularia* sp. For this species, recruitment was higher at the northern than at the southern platforms.

In contrast, patterns of recruitment were variable for the majority of invertebrate taxa with short-lived larvae or direct development. For most of these species, there was no relationship between recruitment and location; many of these organisms recruited at only a few platforms (e.g., *Diplosoma listerianum*) or a single platform (*Watersipora cucullata)* where mature colonies occurred in high abundance. This recruitment pattern is consistent with the short larval development time and limited dispersal of these species. Although there was an association between recruitment and location for hydroids, their limited dispersal ability (crawl away larvae) suggests that oceanographic factors associated with water masses likely had little influence on

transport of the hydroid larvae and subsequent recruitment. Instead, biological interactions (predation, competition) or other factors may have influenced the recruitment patterns of this taxon.

Our water temperature data provide support for the hypothesis that oceanographic factors influenced recruitment patterns in the summer for those species with longer-lived planktonic larvae, as a gradient in water temperature occurred along the Santa Barbara Channel during this season. In particular, warm water intrusion was detected at the southern, but not at the northern platforms (Fig. 5). There was a significant correlation between barnacle (*B. trigonus*) recruitment and water temperature in the summer, both with ($p = 0.05$, Spearman's Rho) and without ($p = 0.0003$) the outlying data from Platform Gina (Fig. 6). This suggests that larvae of warm water species could have been transported in these water masses during the summer.

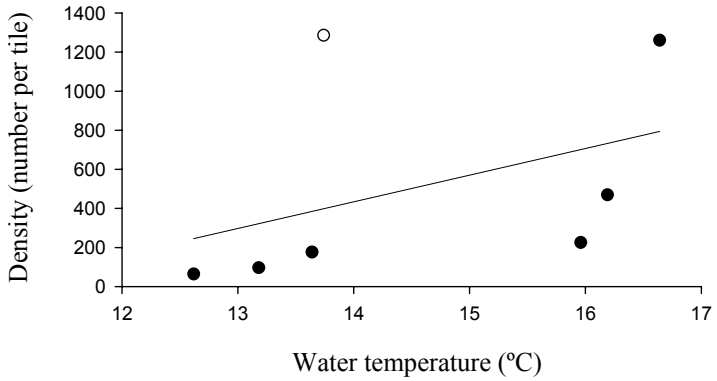


Figure 6. The relationship between recruitment of *Balanus trigonus* and water temperature (mode) at each location. Open circle = Platform Gina.

Table 2. The relationship between recruitment of selected invertebrates and location in the channel. Rs = Spearman correlation coeffiencient. * < 0.05; ** < 0.01; *** < 0.001. nsv = no significant variation in recruitment. nr=no recruitment

Species	Summer 2001	Fall 2001	Winter 2002	Spring 2002
Barnacles				
Balanus trigonus	-0.857**	-0.893***	0.607	0.509
Megabalanus californicus	nsv	-0.321	nsv	-0.786*
Balanus regalis	nsv	nr	nsv	-0.821*
Encrusting bryozoans				
Watersipora cucullata	-0.204	-0.204	nr	-0.204
Other encrusting bryozoans	nsv	-0.107	-0.054	0.071
Branching bryozoans				
Crisia complex/				
Bugula neritina	0.071	0.036	-0.286	0.029
Hydroids				
Plumaria sp.	0.901***	nsv	0.056	0.089
Tunicates				
Diplosoma listerianum	0.445	0.0490	0.0490	0.045

GENETICS:

Summary of Research

Progress during 2002-2003

We have made significant progress on determining the genetic variation among samples of *Bugula neritina* during this last year. During this time, we have significantly expanded our collections in order to obtain a large, representative sampling of *B. neritina* from OCS oil platforms as well as natural populations along the mainland coast and the California Channel Islands. We have particularly focused our efforts on samples from the Channel Islands because these populations are much more likely to be isolated and to therefore contain unique genetic variants that would be signatures we could use to identify the sources of *B. neritina* on OCS platforms. During this time we have nearly doubled our collections to include approximately 200 samples. This wide and varied sampling will be extremely important in our determination of the degree of genetic variation (and thus potential variation in bryostatin compounds) in this species. All of our samples have now been identified, cleaned and their DNA isolated and quantified. This task in itself is fairly time consuming because it is necessary to remove any fouling organisms that could contaminate DNA isolations.

We have also now PCR amplified and sequenced a 1.4 kb portion of the mtDNA for 160 of these samples. Last year we developed PCR primers for this region of the DNA because so little is known about Bryozoan DNA. This sequencing has resulted in nearly a one half million base-pairs sequenced and will allow us to examine the population biology of these organisms at a fine-grained level. Currently we are checking our sequence analysis and will then determine if there are biogeographic patterns to the genetic variation we find. We already know that there is at least one new lineage of *Bugula neritina.* Once this analysis is complete we will then amplify and sequence the symbiotic bacterium that is the source of the anti-cancer compound bryostatin-1. We will use the mtDNA from *Bugula neritina* as a guide to which samples may harbor new bacterial types. Also during this next year, we hope to collect and culture the new *B. neritina* type we have found (and any others our analysis uncovers) here at UCSB. If we are successful, we will then determine if it harbors new types of bryostatin compounds.

PHARMACOLOGY:

Background

Marine organisms that inhabit the subtidal structures of offshore oil production platforms are a potential source of novel compounds for pharmaceutical use. These organisms provide an unparalleled opportunity to study natural product chemistry from populations of organisms living in ecologically unique habitats. Since the last progress report, we have positively identified the organisms, optimized extraction procedures to obtain the highest biological activity and began purification of the crude extracts on high performance liquid chromatography.

Summary of Research

Progress during 2002-2003

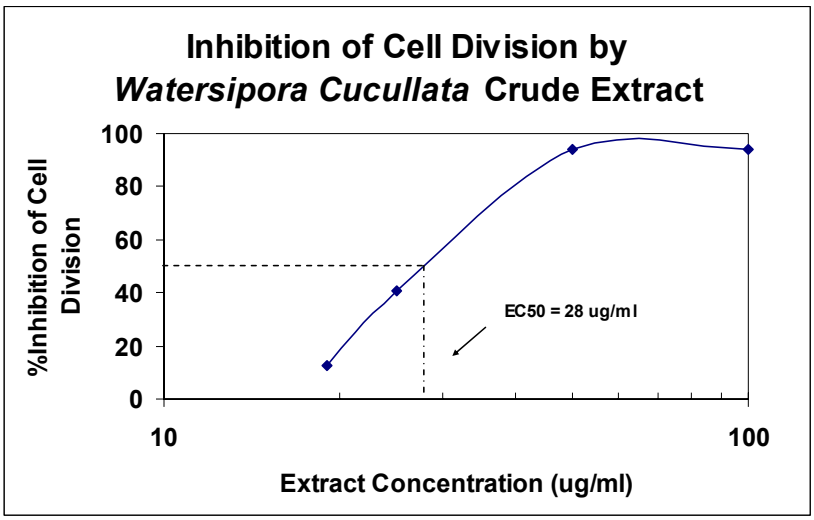
Identification of Organisms

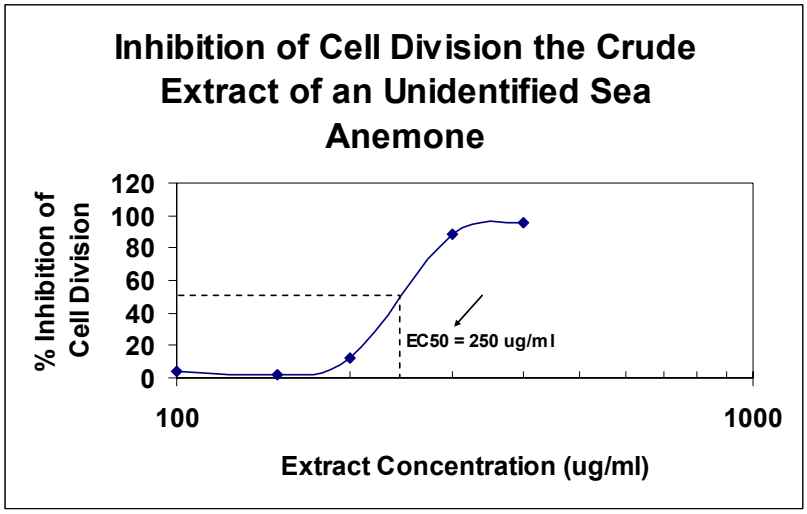
Summer 2002
Vouchers of the three platform organisms we are studying were by the scientific staff at Santa Barbara Museum of Natural History. Preserved and live specimens of each were subsequently sent to experts in the field for proper identification. The bryozoan once referred to as *Hippodiplosia insculpta* was discovered to actually be *Watersipora cucullata* and will be now referred to as that. The sea anemone formerly known as *Metridium exiles* is still currently in the process of identification and will be referred to as an unknown anemone. *Corynactis californica* was correctly identified.

Winter 2003
The laboratory of Dr. Daphne Fautin at the University of Kansas, Lawrence, has been examining both preserved and live specimens of a sea anemone initially identified as *Metridium exiles*. They are finding very interesting and unique structural information such as tiny bodies (about a micron in diameter) in the mesoglea of the body wall. They have not found a comparative in the taxonomic literature or in data bases that is remotely morphologically similar to sections they have taken, leading to the exciting conclusion that this may be a yet unidentified anemone. We have re-supplied them with additional collections and they are currently conducting bacteria-diagnostic stains and vital stains to confirm their results.

Biological Activity of Crude Extracts

Summer 2002
The biological activity of crude extracts of *Watersipora cuculatta* and unidentified anemone were confirmed. The dose response curves presented here.





Fall 2002
For HPLC application, the organisms are extracted using an optimized method designed for the organism and fractionated using a flash column to obtain a semi-pure extract. After activity of the fraction is confirmed using the sea urchin assay, the semi-crude preparation is analyzed in the UV spectrophotometer then the extract is purified by HPLC. All the active fractions were lipid soluble in chloroform or combinations of methanol-chloroform, based on this polarity, we began using straight-phase silica HPLC columns to begin separation. In the case of the unknown anemone and *Corynactis califonica*, the semi-pure extracts were separated on straight phase using a gradient of hexane in ethyl acetate. Fractions were collected and evaluated for activity using the sea urchin assay. In both cases, an active group of peaks was located.

In the case of *Watersipora cucullata*, straight phase HPLC did not produce any usable results, so we began to separate this extract on reverse phase activated C18 silica columns. Using an isocratic mobile phase of 94 methanol: 4 Acetonitrile: 2 water, an active peak was located. Currently we are in the process of re-purifying the active peaks on HPLC to further separate and identify one pure active substance.

Winter 2003
1) Bioassay-Guided fractionation of semi-pure extracts using HPLC for *Corynactus californica* and the unidentified anemone: For HPLC purification, the organisms are extracted using our optimized method designed especially for the organism and fractionated using a flash column to obtain a semi-pure extract. After activity of the fraction is confirmed using the sea urchin cell division assay, the semi-crude preparation is characterized spectrophotometrically then the extract is purified by HPLC.

In the case of the unidentified anemone, 100% bioactivity was retained in the (50/50) chloroform-methanol fraction, which showed a pure UV scan with an intense signal at 243 nm. This fraction was run on HPLC and the major peaks were collected. We are in the process of analyzing each peak for bioactivity. Preparative thin layer chromatography may be employed as well as a tool to further purify the extract.

The active fractions in *Corynactis califonica* were lipid soluble in chloroform and markedly inhibited sea urchin embryo division. Based on the polarity of the extract, we have been using straight-phase silica HPLC columns to further fractionate the extract on a gradient of hexane in ethyl acetate. Fractions were collected and evaluated for activity using the sea urchin assay. An active group of peaks have been isolated.

2) Bioassay-Guided Fractionation of *Watersipora cucullata:* As was mentioned in the last report, the extracts of *Watersipora cucullata* was separated on reverse phase activated C18 silica columns, using an isocratic mobile phase of 94 methanol: 4 Acetonitrile: 2 water, an active peak that was pigmented pink was located. This peak proved very unstable and bioactivity was lost almost immediately. To stabilize the extract, we employed new extraction and storage techniques. The extraction was conducted by lyophilizing the bryozoan and grinding it to a powder and then subjecting the powder to solvents of differing polarities (Hexane, Ethyl Acetate, Methylene Chloride and Methanol), while heating and stirring. The active extract was found in the 100% methylene chloride fraction. To further stabilize the extract we acidified and derivatized the extract with Diazomethane gas to produce methyl esters on terminal carboxylic groups. The extract was stored in 1:1 isooctane/ethanol for stability purposes. This methylene chloride extract with methyl esters was 100% active in the sea urchin cell division assay and separated very well on thin layer chromatography (TLC). Thus we began to use preparative this layer chromatography to separate the fractions further (Figure 3). Layers corresponding to colored bands on the TLC were scraped off and the compounds were extracted from the silica using ethyl acetate, hexanes and methanol. The semi-pure extracts were then evaporated under nitrogen gas and tested in the sea urchin assay. Two specific bands with differing polarities had 100% activity in the sea urchin cell division assay, indicating that there are at least two if not more active compounds in *Watersipora cucullata*.

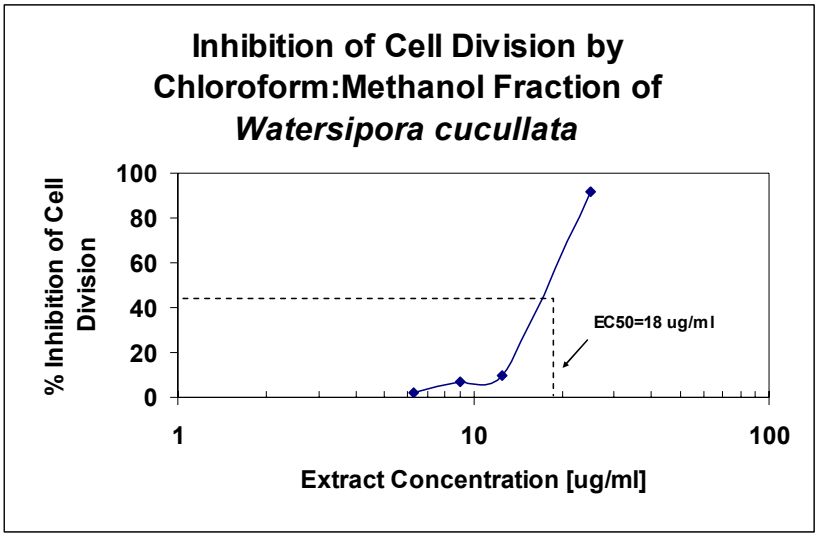
Spring 2003

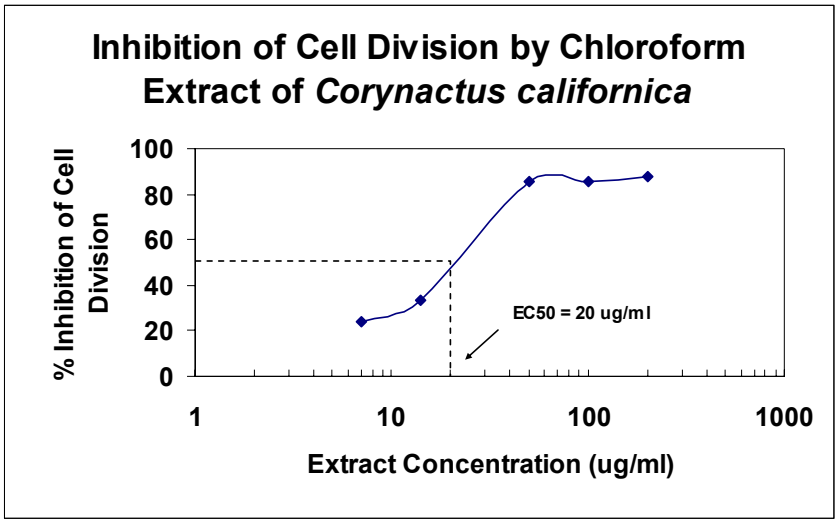
To stabilize the extract, we employed new extraction and storage techniques. The extraction was conducted by lyophilizing the bryozoan and grinding it to a powder and then subjecting the powder to solvents of differing polarities (Hexane, Ethyl Acetate, Methylene Chloride and Methanol), while heating and stirring. The active extract was found in the 100% methylene chloride fraction. To further stabilize the extract we acidified and derivatized the extract with Diazomethane gas to produce methyl esters on terminal carboxylic groups. The extract was stored in 1:1 isooctane/ethanol for stability purposes. This methylene chloride extract with methyl esters was 100% active in the sea urchin cell division assay and separated very well on thin layer chromatography (TLC). Thus we began to use preparative this layer chromatography to separate the fractions further. Layers corresponding to colored bands on the TLC were scraped off and the compounds were extracted from the silica using ethyl acetate, hexanes and methanol. The semi-pure extracts were then evaporated under nitrogen gas and tested in the sea urchin assay. Two specific bands with differing polarities had 100% activity in the sea urchin cell division assay, indicating that there are at least two if not more active compounds in *Watersipora cucullata*. One of the fractions was a yellow pigmented compound; it proved to be very active in the sea urchin assay and had an IC_{50} between 12.5 And 25 ug/ml. This compound also fluoresces under short and long wave UV which was used as tool to isolate large amounts of the compound using preparative TLC. This fluorescence may indicate the presence of a conjugated double bond system. Using electron ionizing mass spectrometry, the main molecular ion of this compound was 272, which may indicate that this is the molecular weight. Analysis of the spectra indicated the presence of an alkene chain and potentially an aromatic ketone or ester structure which is

supported by the UV activity of the compound. We are currently isolating material for analysis on proton and ^{13}C NMR.

Optimization of extraction procedure

Summer 2002
In order to obtain a better yield the extraction procedures for all three organisms was modified. In the case of *Watersipora* and the unknown anemone the extraction was prepared directly from a freeze dried organism. *Corynactis californica* extracts continue to be prepared by homogenizing wet frozen anemones in filtered seawater in a blender and the homogenate was extracted into two phases: a lipid/organic extract and a water/methanol. The crude extracts were partitioned into various solvents, methanol, chloroform and hexane in a solvent-solvent partition and partitioned using a silica gravity column. The gravity column allowed a more detailed fractionation of the extract using 10 different solvents comprised of differing percentages of chloroform in methanol. The different fractions were tested in the sea urchin assay and activity localized to at least one fraction. In all cases information obtained by the gravity column has led to the development of a more efficient and direct method of extracting the active material from the organisms in a semi-crude form. The active fractions for the unknown anemone and *Corynactis californica* were from a 100% chloroform extract, the active fraction in *Watersipora* was obtained using a 50/50 chloroform methanol extract. Dose response curves for the chloroform fraction of *Corynactis californica* and the active fraction for *Watersipora cucullata* are presented here.





Coumarin work arising from studies of Dasycladales

Summer 2002
Previously we characterized the effects of dicoumarol on the distribution of sea urchin embryos in stages of the cell cycle and on the organization of microtubules and chromosomes in metaphase spindles by indirect immunofluorescence staining of microtubules and 4,6-diamidino-2-phenylindole staining of chromatin. At high concentrations (50 μM), dicoumarol produced abnormal organization of mitotic spindle microtubules with chromosomes that had not congressed to the metaphase plate. This summer we characterized the effects of low and medium concentrations of dicoumarol (5 μM, 10μM) and found chromosomes that had not aligned properly to the metaphase plate in all instances. In addition, we observed a unique effect of the drug in that it appeared to inhibit nuclear envelope breakdown. We are currently working out the conditions to characterize the effects of the drug on nuclear lamina assembly and disassembly by indirect immunofluorescence. Thus far, our data indicate that the anti-proliferative mechanism of action of dicoumarol and other coumarin compounds is apparently mediated by tubulin binding and the kinetic stabilization of spindle microtubule dynamics.

Winter 2003
1) Coumarins Isolated from *Bytophera* - Background and Evolutionary Significance: *Batophora oerstedii* belongs to the order Dasycladales, a group of primitive unicellular algae members of the kingdom Protoctista. Dasycladales represents an order of green algae that existed during the Cambrian era 570 million years ago. Most eukaryotes evolved prior to the Cambrina period 640 mya. However, plants (gymniosperms) arose during the carboniferous period 320 mya. Out of 175 Dasycladales known genera, only 11 extant genera remain today. Because of this low number, scientists have classified them as “living fossils” and have suggested that an extinction of this order is at hand.

While most unicellular organisms are microscopic, *Batophora oerstedii* is a unicellular alga 20-70 mm in length and 3-6mm in diameter. It is a widespread and frequently found species that grows on oil production platforms located in the Gulf of Mexico. Coumarins had not been

known as constituents in green algae until in 1983 it was reported for the first time the occurrence of a 3,6,7-trihydroxycoumarin in this order of alga.

We believe that these molecules present in algae are potential not only regulate the growth of epiphytes, but may also function as an internal growth regulator by affecting microtubule polymerization. In the elongated *Dascyladus* cell, organization of the cytoskeleton is involved in its morphogenesis. The oriented transport of materials plays an essential role in morphogeneses. This transport can be visualized as cytoplasmic streaming and is mediated by a concerted action of actin filaments and microtubules. The ability of coumarins to modulate and function in growth by effecting microtubule dynamics has not been investigated. To define further the mechanism of action of these compounds, the purpose of this work is to examine the growth regulatory effect of 3,6,7-trihydroxycoumarin in *Batophora oerstedii* (of the order Dasycladales). Exploration of this coumarin derivative may result in further data concerning the precise mechanism(s) of action of this class of compounds and thus a better understanding of the potential clinical uses.

2) Results of Coumarins Isolated from *Batophora oerstedii:* As seen in Tables 1 and 2, the midpolar lipid extracts of *Batophora oerstedii* are active in inhibiting the cell division of sea urchin embryos. This is expected, since the coumarins would be localized in either the chloroform or ethyl acetate fractions. An interesting observation is that the ethyl acetate fractions in both collections become more active once they are acid hydrolyzed, indicating that once the glycosides are cleaved off the coumarin molecules they become more active.

Table 1. *Batophora oerstedii* Extracts and their effects on Sea Urchin Cell Division

Fraction (100 ug/ml)	Non Acid Hydrolyzed % Inhibition of Cell Proliferation	Acid Hydrolyzed % Inhibition of Cell Proliferation
Crude Extract	**100**	**80**
Hexane	10	8
Chloroform	20	10
Ethyl Acetate	**81**	**100**

Dose Response curves of *Batophora oerstedii* crude extracts (Figure 1) demonstrate an IC_{50} of approximately 44 uM. Chloroform extracts demonstrate a dose response curve (Figure 2) with an IC_{50} of approximately 52 uM.

3) Effects of Dicoumarol on MCF-7 (Breast Cancer) Cell Proliferation: Previously we reported dicoumarol (a coumarin anticoagulant; 3,3'-methylenebis[4-hydroxycoumarin]) inhibits the first cleavage of *S. purpuratus* (sea urchin) embryos in a concentration dependent manner with 50% inhibition occurring at a concentration of 10 μM. We used dicoumarol as the model compound for the effects of coumarins on cell proliferation because it was the most potent of the coumarin compounds we tested. We found that dicoumarol binds to bovine brain tubulin with a K_d of 22 μM, and that 0.1 μM dicoumarol strongly stabilizes the growing and shortening dynamics at the plus ends of the microtubules *in vitro*. The anti-mitotic effects of the widely used cancer

chemotherapeutic agent taxol (paclitaxel) are also mediated by suppressing microtubule dynamics. We demonstrated that exposure to combinations of taxol and dicoumarol results in a synergistic inhibition of cell division of sea urchin embryos. In addition, we found that dicoumarol disrupts microtubule formation and the proper alignment of mitotic chromosomes in sea urchin embryos by immunoflourescence microscopy.

The results suggest that the anti-proliferative mechanism of action of dicoumarol and possibly related pharmacophores may be mediated by tubulin binding and the stabilization of spindle microtubule dynamics.

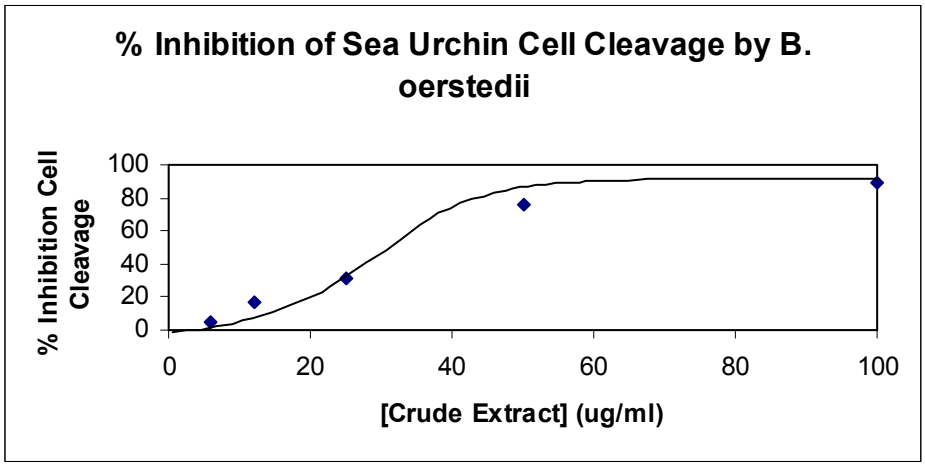
Our previous reports were primarily mechanistic studies using the sea urchin cell division assay as our model system since it is highly selective for microtubule-targeted agents. However, we were interested in seeing the effects of dicoumarol on a mammalian cancer cells, more specifically MCF-7 breast cancer cells. As seen in Figure 3, dicoumarol is able to inhibit the cell proliferation of MCF-7 breast cancer cells with an IC_{50} of approximately 37 uM. We are currently working immunoflourescent microscopy studies on these cells to test if dicoumarol disrupts microtubule formation as in the sea urchin embryo.

Table 2. Comparison of the Effects of Coumarins on Sea Urchin Cell Division and Breast Cancer Cell Division

Compound	IC50 in Sea Urchin Cell Division Assay	IC50 in MCF-7 Breast Cancer Cell Lines
Dicoumarol	10 uM	37 uM
Coumarins in *Batophora oerstedii* (Ethyl Acetate Fractions)	52 uM	

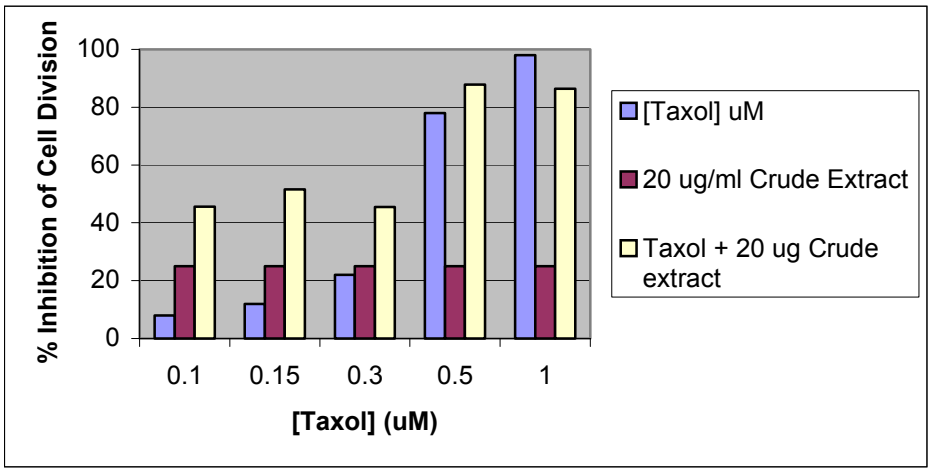
Spring 2003

1) Results of Coumarins Isolated from *Batophora oerstedii:* In our previous report, we reported that the crude extracts of *Batophora oerstedii* were active in inhibiting the cell division of sea urchin embryos. We have now completed a concentration-response curve for the crude extracts and found an IC50 of approximately 30 μg/ml (see figure below).



2) Synergistic Inhibition of Sea Urchin Cell Division by Combinations of *B. oerstedii* and Taxol: Evidence suggests that combination therapy with drugs that stabilize microtubule dynamics by different mechanisms may improve responses and minimize side effects of the individual drugs. Thus, compounds with the same intracellular target, but different binding sites and modes of action, may have the potential to be used in combination for chemotherapeutic purposes. For this reason we evaluated the anti-proliferative activity of taxol (a well-known chemotherapeutic drug) and *B. oerstedii* crude extracts as single agents and in combination for their effects on sea urchin embryonic cell division.

To determine whether the effect of *B. oerstedii* crude extracts on division of sea urchin embryos could be additive or possibly synergistic with the well-known chemotherapeutic agent, taxol, we investigated the combined use of the two compounds. In the presence of 20 μg/ml crude extract (a concentration which inhibits cell division by approximately 25 %), taxol was more effective in inhibition cell division (Fig 1.2). Combinations of taxol with *B. oerstedii* crude extracts produced a more pronounced effects on cell division than when either of the drugs were used alone.



3) Isolation of a Dicoumarol-Like Compound in *B. oerstedii* Extracts: Preparative thin layer chromatography was used to separate the crude extract into fractions (Figure 3). Layers corresponding to colored bands on the TLC were scraped off and the compounds were extracted from the silica using ethyl acetate, hexanes and methanol. The semi-pure extracts were then evaporated under nitrogen gas and tested in the sea urchin assay. The active fraction was analyzed by mass spectrometry and a compound with a molecular weight similar to dicoumarol was obtained. Theses results indicate that the active fraction of the *B. oerstedii* fraction may contain a bishydroxy coumarin compound that is responsible for the anticellproliferative activity in the sea urchin cell division assay.

Assay of Crude Extracts on Mammalian Cancer Cell Lines

Winter 2003

To confirm the biological activities seen in the sea urchin cell division assay, crude extracts of the unidentified anemone and *Corynactis californica* were tested on Hela cells, an ovarian cancer

cell line and A549 cells a lung cancer cell line. The dose-response curves are presented in Figures 5 and 6 and a comparison of the IC_{50} of all the crude extracts of the organisms in our study is presented in Table 3.

Table 3. Inhibitory concentration at 50 % of crude extracts.

Organism	IC_{50} in Sea Urchin Cell Division Assay	IC_{50} in Hela Ovarian Cancer Cell Lines	IC_{50} in A549 Lung Cancer Cell Lines
Unidentified Anemone	250 ug/ml	30 ug/ml	68 ug/ml
Corynactis californica	110 ug/ml	110 ug/ml	110 ug/ml
Watersipora cucullata	28 ug/ml	Studies not completed	Studies not completed

Spring 2003

Preliminary Results on Samples WC-1, 2, and 3: The crude extract (WC-1) was examined for inhibition of HeLa S3 cell proliferation at a range of 10 ng/ml to 10 μg/ml (one experiment). Cells were exposed to drug for one doubling time (24 hrs). The results are as follows:

Drug concentration (μg/ml)	% Inhibition of proliferation	% viability*
10	100	39%
1	38	>90% (same as solvent only control)
.1	6	>90%
.01	0	>90%

*Trypan blue dye exclusion

Task No. 17610: *Industrial Activity and Its Socioeconomic Impacts: Oil and Three Coastal California Counties (A Product of the Joint UCSB-MMS Pacific OCS Student Internship and Trainee Program)*

Principal Investigators: Russell J. Schmitt, Ecology, Evolution, and Marine Biology Department, University of California, Santa Barbara, CA 93106-9610 and **Jenifer Dugan,** Marine Science Institute, University of California, Santa Barbara, CA 93106-6150

Collaborating Scientist: Michael R. Adamson, Marine Science Institute, University of California, Santa Barbara, CA 93106-9610

Summary of Research

Progress during 2002-2003

Analyses and writing culminated in a final report, which was submitted May 20, 2003.

Task No. 17611: *Simulation of a Subsurface Oil Spill by a Hydrocarbon Seep (SSOS-HYS)* and
Task No. 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, University of California, Santa Barbara, CA 93106-9630 **Bruce Luyendyk**, Department of Geological Sciences, University of California, Santa Barbara, CA 93106-9630 and **Ira Leifer,** Institute of Crustal Studies, University of California, Santa Barbara, CA 93106-1100

Project Objectives

The main purpose of the project is to understand the role played by seep bubbles in the transport of hydrocarbons including oil from the seabed to the sea surface. The goal is to validate a numerical bubble model to better predict the surfacing footprint of oil, thereby improving spill mediation efforts and preparedness.

Numerical sensitivity studies showed sensitivity to several parameters, including size, seep depth, upwelling flows, and saturation of the plume water. Since these parameters are largely unknown in the literature, our approach has been to measure these parameters at a very active seep site, Shane Seep. In the process several discoveries were made. Below outlines our progress during the preceding fiscal year.

Summary of Research

Progress during 2002-2003

Bubble measurements

Measurements of the size distribution at the seabed are used to initialize bubble models and thus are highly critical. Difficulties were found in obtaining high quality bubble images that a computer could analyze. The problem was identified as due to bubbles being too close to the illumination screen, a process that was quantified in a paper "Calibrating optical bubble size by the displaced mass method." The solution was to place a second window in front of the illumination screen to create a space between the bubbles and screen. As part of revisions to a paper on bubble measurement systems (Leifer et al., 2003), laboratory experiments were conducted that quantified the magnitude of sizing errors resulting from using slow shutter speeds, i.e., sufficiently fast shutter speeds are now being used. During the fall, video from all the major seeps in the channel except for the La Goleta Seeps was obtained at the sea surface. Video clips are currently half-analyzed. A field trip to measure seabed bubble distributions at Shane Seep is planned for the summer when water visibility will allow a successful mission.

Fluid Motions

Dye release experiments had quantified upwelling velocities in the plume and provided dramatic evidence of the existence of the upwelling flow. Two new approaches to studying the upwelling flow were used to study the importance of the upwelling flow and its interaction with currents. Specifically, a transect of water samples was collected and analyzed for nutrients and showed a consistent and significant elevation in the seep plume versus outside the plume. Also very

informative was the results of an air pollution survey conducted with a portable total hydrocarbon FID at Shane Seep. The survey showed that the strongest air pollution source was downcurrent in a region with no bubbles, demonstrating that the plume of saturated gas had detrained from the bubble plume due to the current and drifted downcurrent.

Seabed Morphology

During the last few years, numerous changes were observed in the seabed morphology and in areas of active seepage (i.e., vent activation and deactivation). These changes were identified as related to transient seepage events that were observed both directly and through air pollution records. Although not an initial focus of the project, bubble pulses from seep ejections provide a very useful model of the initial stages of a blowout, and thus efforts are in progress to study the process. This has included seabed surveys. These surveys have shown activation and deactivation of vents, and provided insight into the mechanism behind the formation of the hydrocarbon volcanoes. An ROV was used to survey the area around Shane Seep beyond the area easily reachable by divers, and demonstrated that seepage lies along a line ~100 m long. The largest mud volcanoes were found at the areas of greatest seepage, with a few small features outside the currently studied area.

Geochemistry

Gas samples collected and analyzed have suggested that Shane Seep emissions have an unusually high CO_2 concentration (~12%). The CO_2 does not reach the surface but almost entirely dissolves during the first ten meters of rise. Measurements also suggest that there may be some fractionation of the gas between major and minor vents. Since surface bubble distributions and surface trace gas compositions suggest that much of the seep emission may be from the minor vents, a field trip is planned to resolve this issue.

Dissemination

In addition to dissemination by conferences and papers during this time period listed elsewhere in this report, a significant effort at dissemination was through a workshop on Shallow Hydrocarbon Migration hosted at UCSB. As part of this workshop, mechanisms underlying hydrocarbon were discussed, as was the potential impacts (positive and negative) on the ecosystem. Most recently, Ira Leifer has collaborated with OSPR in two field trips to investigate the leakage of oil from the capped Treadwell Oil Well located off Summerland, California, including helping with in collection of oil and gas being released from a nearby natural seep that is the majority cause of visible surface oil slicks.

Task No. 18212: *Transport over the Inner-Shelf of the Santa Barbara Channel*

Principal Investigators: Carter Ohlmann, Institute of Computational Earth System Science, University of California, Santa Barbara, CA 93106-3060

Project Objectives

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.

Summary of Research

Progress during 2002-2003

The primary tasks accomplished during the last year include development of a software system for drifter monitoring, development of a software system for drifter data processing, and initiation of the routine data collection program. The drifter monitoring software is a MATLAB based system that displays near real-time position of all active drifters on a scalable map of the coast. Drifter identification number, the most recent position data, and the in-water flag are displayed for each track. The display automatically updates every 60 seconds. The near real-time map of drifter positions enables drifters to be retrieved prior to beaching. In addition, the software facilitates efficient retrieval of all drifters at the end of each experiment.

The drifter data processing software is a MATLAB based system that reads raw position data recorded by each drifter, removes erroneous data points, adds interpolated water depth to each position record, and computes velocities. The water depth data used is the Channel Islands National Marine Sanctuary 60 m resolution data developed by integrating USGS Digital Line Graphs (DLG) and NOAA GEODAS bathymetry points to generate a triangulated irregular network (TIN) model. Accuracy of the model was tested by comparing grid cell values to known point values collected via NOAA hydrographic surveys. Velocity computations are performed in both north-south and along-shore – across-shore coordinate systems. The processing code ultimately quantifies surface current velocities and the rate at which the water depth along each drifter track changes. Plots of these quantities for all drifter tracks are available on the web (http://www.icess.ucsb.edu/~bchinn/). The web site presently includes only plots. A complete suite of pages with explanatory text is being developed.

Finally, routine drifter sampling has begun. Mr. Brian Chinn, an undergraduate student in the Mechanical and Environmental Engineering Department at UCSB were hired to assist with data collection efforts. Mr. Chinn has been deploying the suite of 18 drifters for a day nearly once each week (a few weeks have been missed for drifter maintenance, boat maintenance, and do to closure of the boat launching facility). A total of six routine sampling days have occurred. A sufficient number of drifter tracks will soon be available to begin analysis of the circulation at the study site.

Task No. 18213: *Use of Biological Endpoints in Flatfish to Establish Sediment Quality Criteria for Polyaromatic Hydrocarbon Residues and Assess Remediation Strategies*

Principal Investigators: Daniel Schlenk, Department of Environmental Sciences, University of California, Riverside, CA, 92521

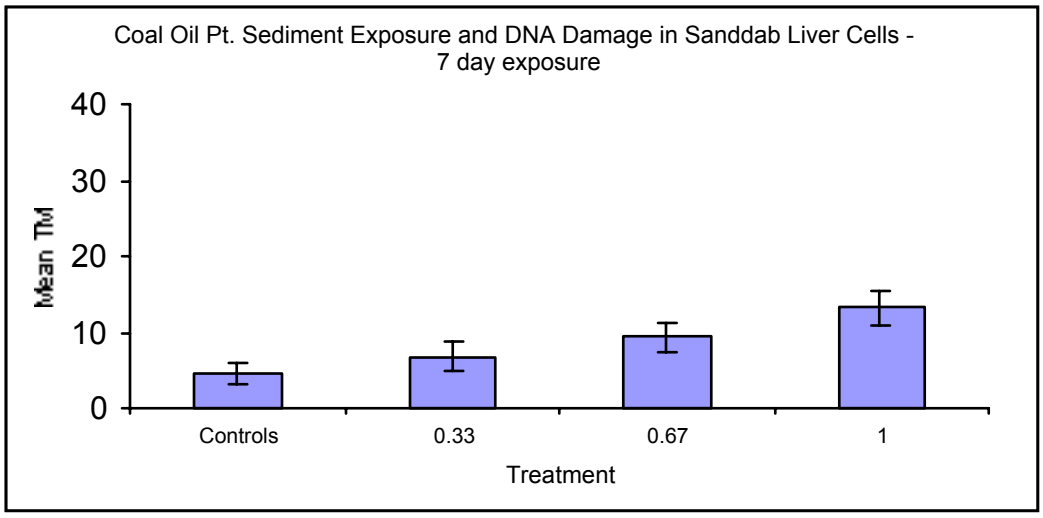
Consultant: Scott Steinert Computer Sciences Corporation, Marine Sciences Department, San Diego, CA.

Summary of Research

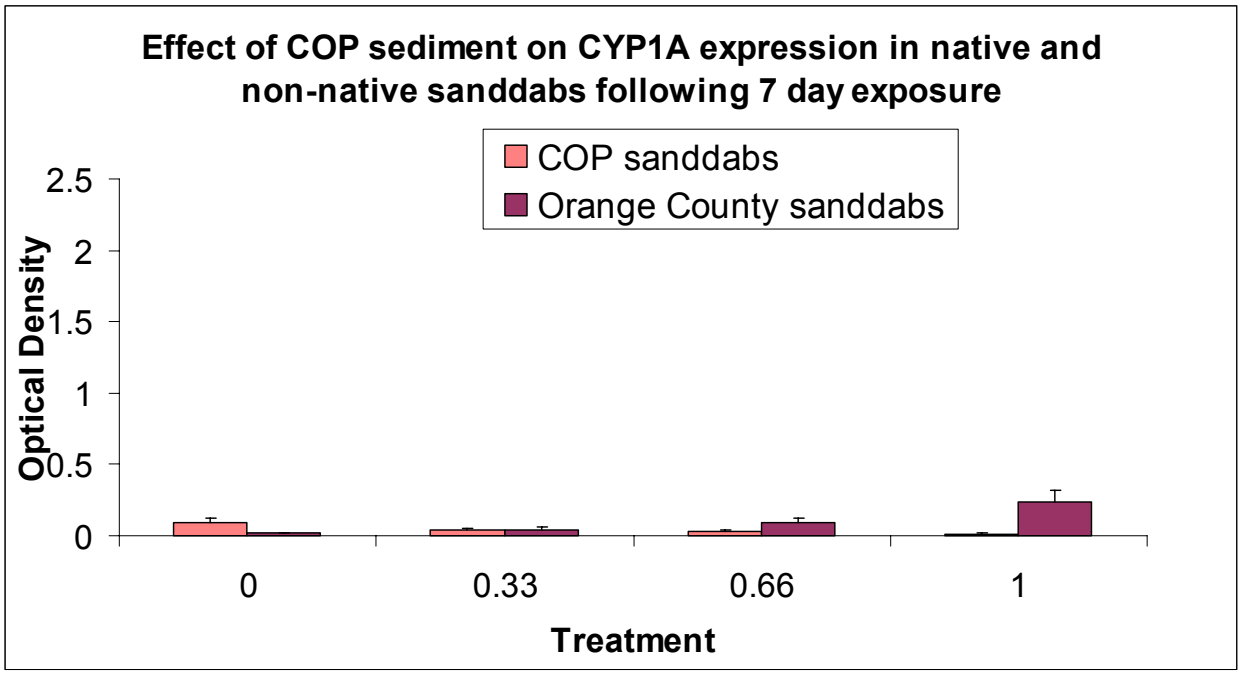
Progress during 2002-2003

California Halibut were obtained from Hubbs Seaworld and treated with 0, 33, 67, and 100% Coal Oil Point sediment for 7 and 28 days. Speckled Sanddabs were collected from Coal Oil Point and off the coast of Orange County and exposed for 7 days to the same dilution profile as above. CYP1A and DNA damage was evaluated in the Sanddabs. CYP1A, FACs, DNA damage (blood liver, gonad) Gonadal Somatic Indices, and plasma steroids (Testosterone and Estradiol) were measured in the Halibut after treatment.

Similar to previous results in Hornyhead turbot, DNA damage in Sanddab was linear with PAH concentration.

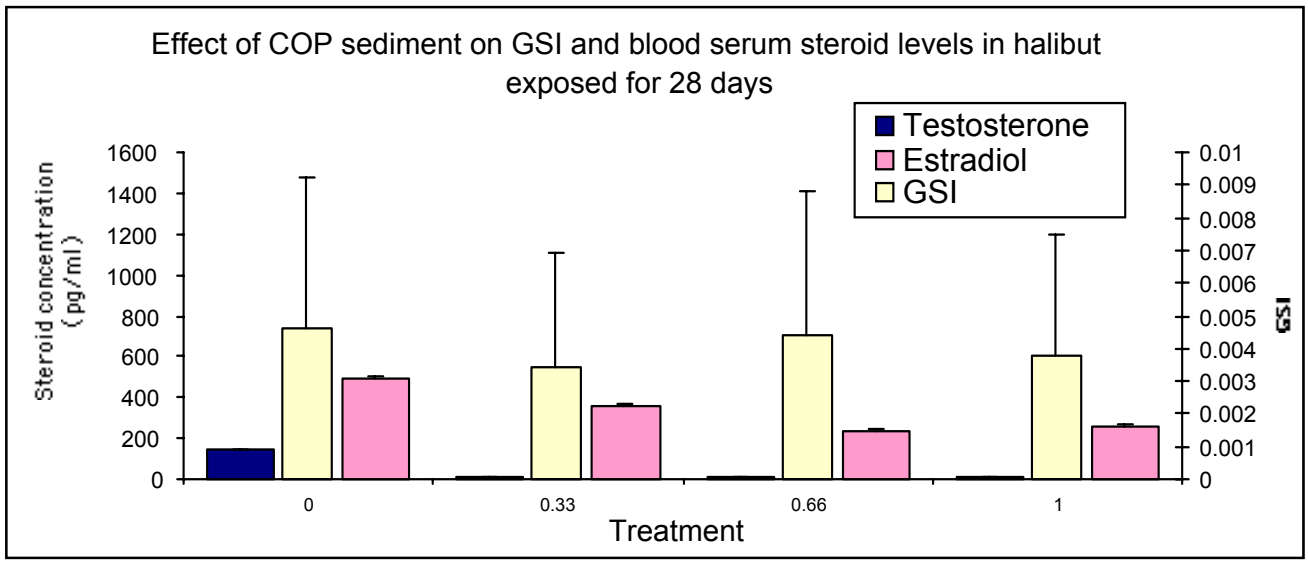


However, hepatic and gonad DNA damage was not correlated with PAH sediment concentrations for halibut after 7 days of exposure. No dose-response relationship was observed for GSI or FAC concentrations in Halibut from either 7 or 28 days of exposure. Naphthalene and Phenanthrene-type PAHs were the highest class which is consistent with unurbanized PAH. Saturation of effect occurred at the 33% COP sediment.



CYP1A of Speckled Sanddabs from an uncontaminated site in Orange County and Coal Oil Point were induced in a dose-dependent manner following treatment. However, CYP1A from Coal Oil Point fish indicated repression of the CYP1A response. This response is consistent with *Fundulus heteroclitus* responses observed in heavily urbanized waterways contaminated with either dioxins or petrogenic PAHs. CYP1A in halibut was not related to PAH sediments, although induction appeared to occur after 28 days of exposure.

As observed in earlier studies with turbot, plasma steroids were significantly impacted by COP sediment treatment. Concentrations of testosterone were not detected in any of the fish maintained in the COP-treated after 28 days. A similar trend was observed in the 7 day exposures. E2 concentrations were likewise inversely related up to 67% COP.



In summary, it appears that Sanddabs are the most sensitive for DNA damage which is highly related to CYP1A expression thus providing the best linear response in this species.

In Halibut, no endpoint demonstrated a linear response to PAH exposure. The most sensitive response to PAH concentrations in halibut and turbot appear to be plasma steroid concentrations after 7 days of exposure.

Future Plans

Halibut exposure to 1:100 dilutions of the Coal Oil Point sediment was completed May 15. Samples are to be analyzed this summer for the endpoints above.

Problems Encountered

Two additional fish kills occurred as water was inadvertently shut down in the middle of the 28 day exposures.

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

Principal Investigators: Peter Raimondi, Department of Ecology and Evolution, University of California, Santa Cruz, CA 95060 and **Richard Ambrose,** School of Public Health, Department of Environmental Sciences, University of California, Los Angeles, CA 90095-1772

Summary of Research

Progress during 2003-2003

Because the funding for this project has only just recently been made available, there has been very little work done on this project to date. We have made one scouting trip to determine where exactly the experimental plots will go. We looked for potential sites at Cayucos, Hazards, Stairs, Lompoc Landing, and Boathouse, and determined there was suitable habitat at all sites visited. We used the criteria of amount of suitable habitat, level of site-specific characteristic recruitment, and proximity to existing monitoring sites to make the following decisions regarding where the experiment will be set up.

Because Stairs is where we have more information from the Shoreline Inventory project, we decided that Stairs would be chosen over Lompoc Landing since the two are so close together. We also decided that Cayucos may be chosen over Hazards since there tends to be higher recruitment at that site based on data collected by the Shoreline Inventory project, and the Stairs area tends to have lower recruitment. It will be an important aspect of the experimental design to set up plots at some sites that have chronically low recruitment and others that have characteristically higher recruitment. Boathouse will potentially be used as well. We have not decided yet whether or not there will be one site South of Point Conception, due to the low abundance of rockweeds in that vicinity.

Future plans

We will set up experimental disturbance plots at 4 sites. These plots will examine specifically the effect of clearing size on the rate and extent of recovery. As such, we will make clearings of a gradient of sizes ranging from tiny (8 cm x 10 cm) to large (50 cm x 30 cm) in three species assemblages in the upper-middle intertidal; the barnacle assemblage, the *Endocladia* assemblage, and the *Silvetia* assemblage. Each of these target species has a different combination of life history traits that can potentially factor importantly into their extent of recovery. If time and feasibility allow, we will extend the design to include experimental plots in the mussel zone as well.

Additionally, coupled with these cleared plots, we will put out standardized collectors for the recruits of barnacles, *Endocladia* and *Silvetia* at all sites. We will put all three types of collectors in all three zones, with the exception of *Silvetia* collectors in the barnacle zone. This will allow us to examine the role of recruitment between sites as a function of rate of recovery. To quantify site-specific recruitment of all three target species, we will count the number of recruits within a 10 cm x 10 cm area on the natural substrate adjacent to all collectors.

Task No. 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 93106-9630

Summary of Research

Progress during 2003-2003

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) the development of techniques to quantify rates of microbial consumption and decomposition of aromatic and polycyclic aromatic compounds in marine environments and (2) determing the intermediates and end products arising from microbial decomposition of these most persistant and harmful hydrocarbons.

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

To date we have acquired a HP 5890 series II gas chromatography (GC) system with a flame ionization detector to be used for hydrocarbon identification and subsequent quantification. This system has been equipped with an AT-5 MS 30 m x 0.25 i.d. GC column with a film thickness of 0.25 μm, purchased using MMS-CMI funds provided. A variety of gases including Helium, Hydrogen, Nitrogen and air have also been purchased and are plumbed to the GC system. The GC is now functioning and we are developing chromatographic methods to establish fingerprint patterns and standard curves for the quantitation of benzene, naphthalene and benzo(a)pyrene. Chemicals including methylene chloride, hexanes and methanol have also been purchased with MMS-CMI funds and will be used for oil fraction separation and extraction. A Beckman Coulter LS 6500 Multipurpose Scintillation Counter has also been purchased and is to be used in coordination with the GC system in order to establish rates for microbial consumption of radio-labeled substrates.

The P.I. and graduate student have received research scuba diving certifications from the University of California, Santa Barbara. These certifications are essential for the collection of samples from hydrocarbon seeps located in the Santa Barbara channel. Sediment and surface-water samples have been collected from Shane seep during a recent research cruise. A second

sampling trip was unsuccessful due to windy weather, which has also caused the cancellation of subsequent sample collection trips. The weather should improve as summer approaches, which will allow for the collection of samples throughout the remainder of the year. The collection of environmental samples is vital for establishing rates of physical weathering and to distinguish physical from microbial weathering processes.

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

All items mentioned above in the technique development section also apply to this section. In addition to being used for *(1),* the HP 5890 series II gas chromatography (GC) system with a flame ionization detector will also be used for the determination of intermediates and products of microbial weathering and subsequent quantification. The Beckman Coulter LS 6500 Multipurpose Scintillation Counter purchased will be used in coordination with the GC system in order to establish rates for microbial consumption of radio-labeled substrates.

Future plans

We plan to continue collecting oil, gas and sediment samples from Shane seep located approximately 1-mile offshore Goleta, CA throughout the summer. We will continue experimenting with extraction and separation methods required for identification and quantification with the GC system described above. The purchase of the hydrocarbon extraction/evaporation system is planned for the near future. In addition to the above planned purchase, a new model of radioactivity gas detector (RAGA, Shell-Raytest Industries) will soon be on the market and will be purchased for use on this project. Other plans include establishing fingerprint patterns and standard curves to be used for the quantitation of benzene, benzo(a)pyrene and naphthalene.

Task No. 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 93106-6150 **Jenifer Dugan,** Marine Science Institute, University of California, Santa Barbara, California 93106-6150 **Milton Love,** Marine Science Institute, University of California, Santa Barbara, California 93106-6150 and **Hunter Lenihan,** Bren School of Environmental Science & Management, University of California, Santa Barbara, California 93106-5131

Summary of Research

Progress during 2002-2003

The primary goal of this project is to explore whether indices of ecological performance (e.g., size, individual growth) of a model fish and its invertebrate prey differ between platforms and natural reefs. During the past year, we evaluated several natural reef and offshore platforms as potential study sites. We were particularly concerned about selecting natural reef and platform sites that have adequate densities of our model fish, the painted greenling (Oxylebius pictus). Our goal was to locate sampling sites with painted greenlings at comparable depths. After dive trips to assess the densities of painted greenlings at depths of from 0 to 24 m, we selected Naples and Mohawk Reefs and Platforms Holly and Houchin and a depth of ~ 9 m as study sites for the detailed sampling of the model fish and invertebrate prey. Fixed sampling sites have been established at these locations.

We have commenced the sampling of potential food items of painted greenlings, primarily small amphipod crustaceans, along transect lines at each natural reef and platform locations. Samples are taken within randomly placed 20 x 20 cm quadrats using a combination of scraping and vacuum sampling. On return to the laboratory, prey items are separated from non-prey material that commonly includes turf forming algae and, from the platforms, mussels and other macroinvertebrates. The major non-prey components of the benthic habitat in each sample, such as the benthic algae, are also quantified in terms of weight or volume. Following this coarse processing, prey items will be identified, counted and weighed, and for some taxa measured. To date, we have conducted two rounds of sampling (late April-early May, late May-early June) and taken a total of 63 samples. Preliminary data indicates that the platform and natural reef habitats used by small crustaceans differ dramatically in the relative biomass of macroinvertebrates and algae (Fig. 1). The platform locations have a high biomass of mussels and encrusting bivalves while the natural reef locations are dominated by algae.

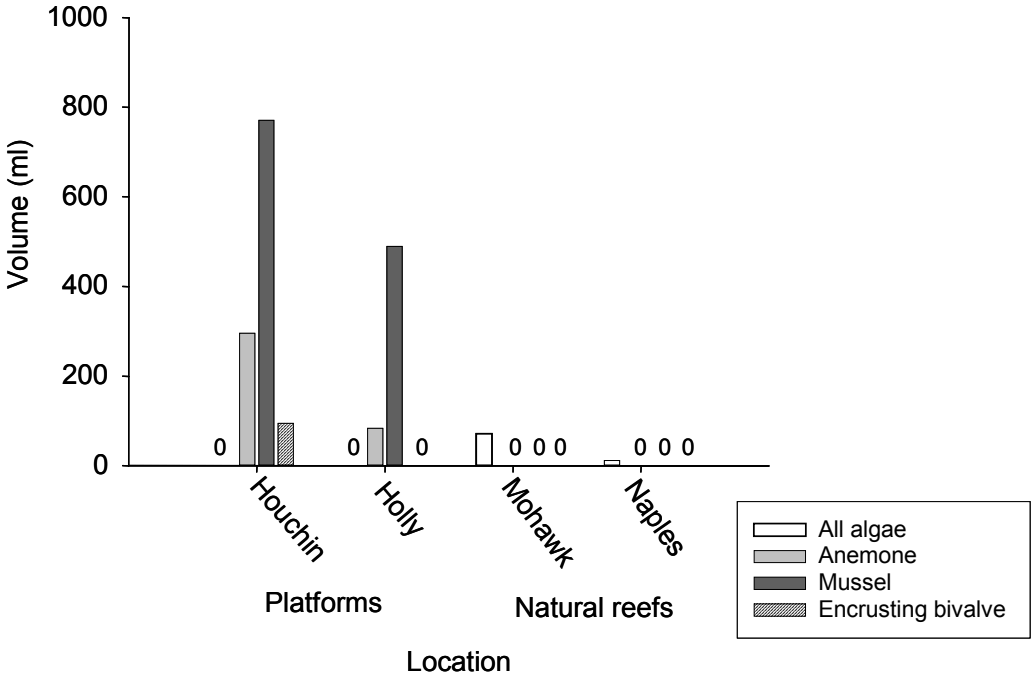


Figure 1. Average biomass (as volume) of major groups of organisms at platform and natural reef study locations. Grouped data from two monthly samplings. n=8 to 12 quadrats/location in each month.

During the upcoming year we will continue the monthly sampling of invertebrate prey at Naples and Mohawk Reefs and Platforms Holly and Houchin, measure components of production of these taxa, sample to test whether the nutritional condition and growth of our model fish differs among these locations and in different regions of the Santa Barbara Channel, and conduct experiments on fish feeding behavior to link prey and predator performance.

Another goal of this project is to investigate and compare trophic structure between platform and natural reef habitats. To this end, we first analyzed fish survey data collected in shallow portions of Platform Holly and Naples Reef during 1995 to 2000. Based on species, size and published data of food habits, we sorted fish into five trophic categories: planktivores, omnivores, "pickers", microcarnivores, and megacarnivores. We then calculated and compared the relative percent abundance of each trophic category among habitat types (platform or natural reef).

There were considerable differences in trophic structure of fish assemblages between habitat types. Platform Holly was numerically dominated by planktivorous fishes (88%), followed by megacarnivores (10%), and microcarnivores (1%). Omnivores and "pickers" were virtually absent at Platform Holly (both less than 1%). This contrasts sharply with the trophic structure of the fish assemblage at Naples Reef which exhibited a more balanced distribution in trophic categories. Here, "pickers" dominated the assemblage (40%), followed by planktivores (29%), megacarnivores (15%) , microcarnivores (13%) and omnivores (3%).

Differences in species composition for each trophic category were also apparent between habitat types. Sardine and juvenile rockfishes (e.g. blue, widow, and olive) were the primary planktivore species at Platform Holly, and blacksmith were the primary planktivore at Naples Reef. The

primary megacarnivore species at Platform Holly was bocaccio, and at Naples Reef it was kelp bass. A diverse assemblage of surfperches formed the microcarnivore category at Naples Reef, including black, pile, rubblerlip, rainbow and striped perches.

The pattern of trophic structure in nearshore fish assemblages between habitats seems to reflect the pattern of percent cover of invertebrates and algae where organisms dependent upon plankton (e.g. mussels and strawberry anemones) were more abundant at platforms compared to natural reefs.

Task No. 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 and Management, University of California, Santa Barbara, California 93106-5131 and **Andy Brooks,** Marine Science Institute, University of California, Santa Barbara, California 93106-6150

Summary of Research:

Progress during 2002-2003

Our accomplishments during the period in question consisted of hiring a fulltime technician, planning our field work for spring 2003, and organizing our laboratory. We conducted a search for a technician/diver through UCSB's Marine Science Institute and the UCSBN Office of Personnel. Our search was successful as we hired an experienced and skilled tech by the name of Mathew Kay, who began work 1 March. Mr. Kay was hired at a level of SRA 1. He has a master's degree in marine biology from the University of Oregon, and is UCSB certified as a scuba diver and boat captain. Matt helped us organize our laboratory space in preparation for our field season which began 1 April 2003.

In addition to hiring a technician, we assembled literature pertaining to our study organisms, conducted maintenance on field gear, and set-up a computer that will be used for data entry, storage, and analysis. Using non-MMS funds, we also purchased a new truck (20 May 2003) that has allowed us to initiate our field work because we can now tow and launch a boat we use for diving activities.

We initiated the fieldwork component of our project by surveying fish communities on our focal platform, Gina, and control sites at Anacapa and Santa Cruz islands. We collected data on the abundance of our model fishes (black-eyed gobies, surfperches, and cabezon) for one time period at our six control sites (3 on Anacapa Island and 3 on Santa Cruz island). We are sampling water depths of 20, 30, 40, and 60 feet. These species were selected after we surveyed platform Gina and found that there were no painted greenling, a species we selected as one of our original model fishes (along with stirped surfperch). Painted greenlings were reported to be abundant on Gina and other platforms but we have not found one specimen on platform Gina and other nearby platforms in our many preliminary dive surveys. As a result, we are excluding the painted greenling as a model species and replacing it with the black-eyed gobie (*Coryphopterus nicholsii). C. nicholsii* is an excellent model species for our project because it is build nests, lays eggs, and does not have pelagic larvae. Therefore, we have the ability to measure the parameters necessary for quantifying births, deaths, emigration, immigration, and growth.

Future plans

Our future plans consist of sampling population demographics of our study organisms at POCS platforms and natural reefs in June, July, August, and September. However, sampling will continue until the fishes have ceased reproducing and we have finished counting and/or tagging all nests, juveniles, and adults.

TRAINEES AND STAFF

TRAINEES AND STAFF FUNDED BY THE COASTAL MARINE INSTITUTE

2002-2003

Name	Status	Task
Alfano, Christine	Graduate Student	Sea Otter Population Dynamics
Anghera, Michele	Post-Graduate Researcher	Population Trends
Anghera, Mike	Staff	Surfgrass Population Genetics
Arkema, Katie	Graduate Student	S. Shoreline Inventory
Arnold, Christine	Undergraduate Student	Sea Otter Population Dynamics
Ashley, Erin	Undergraduate Student	Marine Biotechnology
Bassin, Corrine	Graduate Student	Surface Circulation
Bayer, Pam	Staff	UCSB-MMS Internship
Bean, Jessica	Undergraduate Student	UCSB-MMS Internship
Beckenbach, Edwin	Graduate Student	Surface Circulation
Bellquist, Lyall	Undergraduate Student	Marine Biotechnology
Bentall, Gena	Staff Research Technician	Sea Otter Population Dynamics
Bergquist, Sean	Staff	S. Shoreline Inventory
Beyer, Sabrina	Undergraduate Student	Ecological Performance
Bomkamp, Rachel	Graduate Student	Habitat Value of Shell Mounds
Bram, Jason	Graduate Student	Habitat Value of Shell Mounds
Bricker-Shanahan, Tania	Staff Research Technician	Surfgrass Population Genetics
Bull, Scott	Staff	Surfgrass Population Genetics
Byer, Sabrina	Undergraduate Student	UCSB-MMS Internship
Carlisle, Juliet	Graduate Student	Public Perceptions of Risk
Campbell, Kelly	Undergraduate Student	UCSB-MMS Internship
Chambers, Jeanne	Staff	UCSB-MMS Internship
Chau, Jason	Undergraduate Student	UCSB-MMS Internship
Chess, Katie	Staff Research Technician	Sea Otter Population Dynamics
Chinn, Brian	Undergraduate Student	Transport over the Inner-Shelf
Conway-Cranos, Tish	Staff Research Associate	N. Shoreline Inventory
Cudaback, Cynthia	Staff Research Associate	Surface Circulation
Culver, Carrie	Post-Doctoral Researcher	Habitat Value of Shell Mounds
Day, Daniel	Undergraduate Student	UCSB-MMS Internship
DeMent, Andrea	Post-Graduate Researcher	Population Trends
Deter, Julie	Undergraduate Student	Population Trends
Dunkin, Robin	Undergraduate Student	Sea Otter Population Dynamics
Emery, Brian	Staff Computer Technician	Surface Circulation
Engle, Jack	Post-Graduate Researcher	S. Shoreline Inventory
Falcon, Nicolas	Undergraduate Student	Ecological Performance
Fisher, Rachelle	Undergraduate Student	Ecological Performance
Fowler, Kasie	Undergraduate Student	Sea Otter Population Dynamics
Freeman, Chad	Staff Research Technician	Sea Otter Population Dynamics
Grace, Krista	Staff Research Technician	Marine Biotechnology
Hale, Holly	Undergraduate Student	Ecological Performance
Hamlin, Luke	Undergraduate Student	UCSB-MMS Internship
Hanni, Krista	Undergraduate Student	Sea Otter Population Dynamics
Harlan, Jack	Graduate Student	Surface Circulation
Harris, Mike	Staff Research Technician	Sea Otter Population Dynamics
Haston, Laura	Staff	UCSB-MMS Internship
Haupt, Alison	Undergraduate Student	Ecological Performance
Hessell, Eric	Staff Research Diver	Ecological Performance
Hill, Jason	Staff Research Technician	Sea Otter Population Dynamics
Hoestereg, Justin	Undergraduate Student	Ecological Performance
Jensen, Amanda	Staff	Ecological Performance

2002-2003 (Continued)

Name	Status	Task
Jhan, Sathima	Undergraduate Student	Ecological Performance
Johnson, Robin	Staff	UCSB-MMS Internship
Johnston, Karina	Staff	Ecological Performance
Kage, Alisha	Graduate Student	Sea Otter Population Dynamics
Kane, Corrie	Undergraduate Student	Population Trends
Kay, Mathew	Laboratory Technician	Relative Importance of POCS
Kido, Janine	Post-Graduate Researcher	S. & N. Shoreline Inventory
Kinnaman, Frank	Undergraduate Student	Rates of Microbial Metabolism
Klaib, Jennifer	Undergraduate Student	UCSB-MMS Internship
Lee, Steven	Post-Graduate Researcher	S. & N. Shoreline Inventory
Lester, Sara	Graduate Student	Population Trends
Levy, Carla	Undergraduate Student	Ecological Performance
Luu, Christine	Undergraduate Student	UCSB-MMS Internship
Madari, Hampta	Graduate Student	Marine Biotechnology
Malone, Tim	Undergraduate Student	UCSB-MMS Internship
Mangiardi, Catrina	Graduate Student	UCSB-MMS Internship
Martinez, Pat	Staff	UCSB-MMS Internship
Michaud, Kristy	Graduate Student	Public Perceptions of Risk
Moulton, Joe	Undergraduate Student	UCSB-MMS Internship
Mydlarz, Laura	Graduate Student	Marine Biotechnology
Newnham, Matt	Staff Volunteer	Marine Biotechnology
Ow, Leah	Undergraduate Student	Surface Circulation
Reger, Cian	Undergraduate Student	Ecological Performance
Reese, Stacey	Staff Research Associate	Sea Otter Population Dynamics
Roe, Christy	Staff Research Associate	N. Shoreline Inventory
Roland, Rusty	Undergraduate Student	UCSB-MMS Internship
Ross, Cliff	Graduate Student	Marine Biotechnology
Rowan, Barry	Staff Technician	Habitat Value of Shell Mounds
Russell, Benjamin	Undergraduate Student	UCSB-MMS Internship
Seydel, Keith	Post-Graduate Researcher	Population Trends
Salazar, David	Staff Research Associate	Surface Circulation
Schroeder, Donna	Staff	Ecological Performance
Smith, Jayson	Graduate Student	S. Shoreline Inventory
Tarman, Jenn	Staff	Ecological Performance
Thrower, Douglas	Staff Research Scientist	Marine Biotechnology
Tinker, Tim	Graduate Student	Sea Otter Population Dynamics
Venkatesan, Meera	Staff	S. Shoreline Inventory
Wardlaw, George	Graduate Student	Rates of Microbial Metabolism
Westerlund, Jennifer	Undergraduate Student	UCSB-MMS Internship
White, Jada-Simone	Undergraduate Student	Population Trends
Wilhelm, Frank	Undergraduate Student	Sea Otter Population Dynamics
Williams, Mike	Undergraduate Student	UCSB-MMS Internship
Williamson, Bonnie	Staff	UCSB-MMS Internship
Willis, Allan	Staff	Ecological Performance
Wilson, Melissa	Staff Research Technician	N. Shoreline Inventory
Withy-Allen, Kira	Undergraduate Student	Ecological Performance
Wolff, Tim	Undergraduate Student	UCSB-MMS Internship
Wright, Matt	Undergraduate Student	Ecological Performance
Yeates, Laura	Graduate Student	Sea Otter Population Dynamics
Zimmerman, Eric	Staff	UCSB-MMS Internship

Key
Biological Endpoints in Flatfish—Task # 18213, PI Schlenk
Ecological Performance—Task # 85339, PIs Page, Dugan, Love, Lenihan
Habitat Value of Shell Mounds—Task # 17610, PIs Page, Dugan & Childress
Marine Biotechnology—Task # 17609, PIs Schmitt et al.
N. Shoreline Inventory—Task # 17604, PI Raimondi
Platform Abandonment—Task # 12387, PIs Carr, Forrester, McGinnis
Population Trends—Task # 14181, PIs Schmitt & Brooks
Public Perceptions of Risk—Task # 17607, PI Smith
Rates of Microbial Metabolism—Task # 85338, PI Valentine
Relative Importance of POCS—Task # 85340, PIs Lenihan & Brooks
S. Shoreline Inventory—Task # 17602, PI Ambrose
Sea Otter Population Dynamics—Task # 17605, PIs Estes, et al.
SSOS-HYS—Task #s 17611 & 18211, PIs Leifer, Clark, & Luyendyk
Surface Circulation—Task #, 17608, PIs Washburn and Gaines
Surfgrass Population Genetics—Task # 17606, PIs Hodges et al.
Surfgrass Restoration—Task # 15118, PIs Reed & Holbrook
Transport over the Inner-Shelf—Task # 18212, PI Ohlmann
UCSB-MMS Internship—Task #s 12388 & 17610, PIs Dugan, Keller

RESEARCH PRODUCTIVITY

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Beckenbach, E.H., and L. Washburn. 2002. Observations of Wavelike Phenomena in the Santa Barbara Channel Using HF Radar. *Eos Transactions, American Geophysical Union Ocean Sciences Meeting Supplement, Abstract OS32D-160.*

Leifer, I. and A. Judd. 2002. Oceanic methane layers: A bubble deposition mechanism from marine hydrocarbon seepage. *Terra Nova* **14**(6): 417-424.

Leifer, I. and J. Clark. 2002. Modeling trace gases in hydrocarbon seep bubbles: Application to marine hydrocarbon seeps in the Santa Barbara Channel. *Russian Geology and Geophysics* **43**(7): 613-621.

Leifer, I. and R. Patro. 2002. The bubble mechanism for transport of methane from the shallow sea bed to the surface: A review and sensitivity study. *Cont. Shelf Res.* **22**: 2409-2428.

Leifer, I., Luyendyk, B., and K. Broderick. 2003. Tracking Shane Seep oil from the seabed to the sea surface, at Coal Oil Point, California. *Proceedings: California and World Ocean '02*.

MacDonald, I.R., Leifer, I., Sassen, R., Stine, P., Mitchell, R., and N. Guinasso Jr. 2002. Transfer of hydrocarbons from natural seeps to the water column and atmosphere. *Geofluids* **2**: 95-107.

Madari, H., Panda, D., Wilson, L., and R. S. Jacobs. 2003. Dicoumarol: A unique microtubule stabilizing natural product that is synergistic with taxol. *Cancer Research* **63**: 1214-1220.

Ohlmann, J. C. and A. L. Sybrandy. 2002. A catch-and-release Lagrangian drifter for near-shore ocean circulation research. *Proceedings: California and World Ocean '02.*

Smith, E. R. A. N. 2002. *Energy, the Environment, and Public Opinion*. Boulder, Colorado: Rowman & Littlefield.

IN PRESS

Beckenbach, E. H., and L. Washburn. 2003. Observations of wavelike phenomena in the Santa Barbara Channel using high frequency radar. *Journal of Geophysical Research* (in press).

Bomkamp, R. E., Page, H. M., and J. Dugan. 2003. Distribution and abundance of mobile benthic invertebrates on shell mounds at existing and former offshore oil platform sites (in press).

Brooks, A. J., Schmitt, R. J., and S. J. Holbrook. 2003. Parallel changes observed across several trophic levels suggest a common response by marine communities to short-term climate change. *Ecology Letters* (in prep).

Bull, J. S., Reed, D. C., and S. J. Holbrook. 2002. An Experimental Evaluation of Different Methods of Restoring *Phyllospadix torreyi*. *Restoration Ecology* (in press).

Clark, J. F., Leifer, I., Washburn, L., and B. P. Luyendyk. 2003. Compositional changes in natural gas bubble plumes: Observations from the Coal Oil Point Seep Field. *Geo. Mar Lett*. (submitted).

Cudaback, C., Washburn, L., and E. P. Dever. 2003. Inner-shelf circulation near Pt. Conception California. *Continental Shelf Research* (in press).

Dugan, J.E., Hubbard, D.M., McCrary, M., and M. Pierson. 2003. The Response of macrofauna communities and shorebirds to macrophyte wrack subsidies on exposed sandy beaches of southern California. *Estuar. Coastl. Shelf Sci.* **56** (in press).

Emery, B.M., L. Washburn, and J. Harlan. 200. Evaluating radial current component from CODAR high frequency and moored in situ current meters. *Journal of Atmospheric and Oceanic Technology* (submitted).

Hubbard, D.M. and J.E. Dugan. 2003. Shorebird use of an exposed sandy beach in southern California. *Estuar. Coastl. Shelf Sci.* **56** (in press).

Leifer, I. and I. MacDonald. 2003. Dynamics of the gas flux from shallow gas hydrate deposits: Interaction between oily hydrate bubbles and the oceanic environment. *Earth Plan. Sci. Lett* (in press).

Leifer, I., De Leeuw, G., and L. H. Cohen, 2003. Optical measurement of bubbles: System, design and application. *J. Atm. Ocean. Tech.* (in press).

Leifer, I., De Leeuw, G., and L. H. Cohen, 2003b. Calibrating optical bubble size by the displaced mass method. *Chem. Eng. Sci.* (submitted).

Madari, H. and R. S. Jacobs. 2003. An ethnopharmacological study of medicinal plant extracts used in ancient Persian medicinal formulations. *Journal of Ethnopharmacology* (submitted).

Madari, H., Wilson, L., and R. S. Jacobs. 2003. Analysis of spindle microtubule, chromosome and nuclear lamin organization in dicoumarol-treated and dicoumarol+taxol treated sea urchin embryos (in prep).

Muller, E. B. and R. M. Nisbet. 2002. Sublethal effects of toxic compounds on dynamic energy budgets; theory and applications. *Ecological Applications* (in press).

Mydlarz, L. D., Jacobs, R. S., Boehnlein, J., and R. G. Kerr. 2003. Evidence that the origin of pseudopterosin biosynthesis resides in the dinoflagellate symbiont *Pseudopterogorgia elisabethae. PNAS* (submitted).

Ross, C., Kuepper, F., Vreeland, V., Waite, H., and R.S. Jacobs. 2003. A Descriptive Phenomonology of Wound Plug Formation in the Tropical Chlorophyte *Dasycladus vermicularis* (in prep).

Ross, C., Kuepper, F., and R.S. Jacobs. 2003. A Pharmacological Analysis of the Oxidative Burst in *Dasycladus vermicularis* (Chlorophyta) (in prep).

Roy, L. A., Armstrong, J. L., Sakamoto, K., Steinert, S., Perkins, E., Lomax, D. P., Johnson, L. L., and D. Schlenk. 2003. The relationships of biochemical endpoints to histopathology, and population metrics in feral flatfish species collected near the municipal outfall of Orange County, CA. *Environmental Toxicology and Chemistry* (in press).

Roy, L. A., Steinert, S., Bay, S., and D. Schlenk. 2003. Dose-response evaluations of piscine biochemical endpoints of PAH exposure by sediment obtained from a natural petroleum seep. *Aquatic Toxicology* (submitted).

Santiago-Vázquez L., Mydlarz, L.D., Jacobs, R.S., and J.G. Pavlovich. 2003. Identification of hydroxyl fatty acids by liquid chromatography-APCI mass spectrometry in Euglena gracilis. *Lipids* (submitted).

Smith, E. R. A. N. Public Response to Energy: Overview *In* Cutler J. Cleveland (ed.), *The Encyclopedia of Energy*. San Diego: Academic Press/Elsevier Science, forthcoming 2004.

MMS REPORTS

Deacon, R.T. and C.D. Kolstad. Valuation of Coastal Resources – Understanding Substitution in Time and Space. MMS OCS Study 2003-013. Coastal Research Center, Marine Science Institute, University of California, Santa Barbara, California. MMS Cooperative Agreement Number 14-35-0001-30758. 12 pages.

Raimondi, P.T. and A. Boxshall. Effects of Produced Water on Complex Behavior Traits of Invertebrate Larvae. MMS OCS Study 2002-050. Coastal Research Center, Marine Science Institute, University of California, Santa Barbara, California. MMS Cooperative Agreement Number 14-35-0001-30758. 38 pages.

Reed, D.C. and S.J. Holbrook. An experimental evaluation of methods of surfgrass (*Phyllospadix torreyi*) restoration using early life history stages. MMS OCS Study 2003-034. Coastal Research Center, Marine Science Institute, University of California, Santa Barbara, California. MMS Cooperative Agreement Number 14-35-0001-30758. 96 pages.

Schmitt, R.J. and M.L. Bonnell. Aerial Surveys of Distribution and Abundance of Marine Birds and Mammals in Santa Barbara Channel and the Santa Maria Basin. MMS OCS Study 2003-012. Coastal Research Center, Marine Science Institute, University of California, Santa Barbara, California. MMS Cooperative Agreement Number 14-35-0001-30758. 23 pages.

Schmitt, R.J., Dugan, J.E., and M.R. Adamson. *Industrial Activity and Its Socioeconomic Impacts: Oil and Three Coastal California Counties*. MMS OCS Study 2002-049. Coastal Research Center, Marine Science Institute, University of California, Santa Barbara, California. MMS Cooperative Agreement Number 14-35-01-00-CA-31603. 244 pages.

Washburn, L. and S. Gaines. Summary of findings for using high frequency radar in physical oceanographic and ecological studies. MMS OCS Study 2001-056. Coastal Research Center, Marine Science Institute, University of California, Santa Barbara, California. MMS Cooperative Agreement Number 14-35-0001-30758. 31 pages.

RESEARCH PRESENTATIONS

Boles, J., Clark, J., and I. Leifer. 2002. Methane seepage along faults in the Santa Barbara coastal area: Geological and modern evidence. Poster presentation, Shallow Hydrocarbon Migration Workshop, Santa Barbara, CA.

Brooks, A.J., R.J. Schmitt, S.J. Holbrook, H. Lenihan, and S. Lester. 2003. The use of long-term datasets to examine possible causes of the long-term decline in communities of nearshore fishes off the coast of southern California. Invited speaker in Special Symposium on: Changing Fish Populations, Declining Fisheries, and Marine Protected Areas Southern California Academy of Sciences, Northridge, CA.

Cudaback, C., Washburn, L., Caselle, J., Blanchette, C., and B. Gaylord. 2002. High frequency sampling of nearshore coastal circulation and invertebrate settlement near Santa Barbara California. Eastern Pacific Ocean Conference, Timberline Lodge, OR.

Day, D. and R.S. Jacobs. 2002. Anti-cancer properties of a Marine Natural Extract from *Hippoliplusia insculpta*. CAMP Undergraduate Research Symposium, Aug. 2002 at UC Santa Barbara.

Day, D. and R.S. Jacobs. 2002. Marine Natural Products with Anti-cancer Properties isolated from Watersipora cuculleta.. Southern California Conference on Undergraduate Research, Caltech, Pasadena, CA, Nov. 22, 2002.

Dugan J. 2002. Ecological effects of grooming on exposed sandy beaches in southern California. Paper presented at California and The World Ocean, Santa Barbara, CA

Jacobs, R.S. 2002. Invited speaker at the Symposium on Life Histories of Marine Invertebrates in honor of Mary Rice's retirement, Nov.14-15, 2002, at the Smithsonian Marine Station at Ft. Pierce, Ft. Pierce, FL

Jacobs, R.S. 2002. Invited speaker at the workshop "Marine Natural Products: Studies on their Discovery, Biosynthesis, Pharmacology and Utility" sponsored by the Joint Science & Technology Fund of the US-Egypt Partnership for Economic Growth and Development, Dec. 10-11, 2002, Ismalia, Egypt.

Jacobs, R.S. 2003. Invited speaker at Inflammation 2003, organized by the Inflammation Research Association under the auspices of the International Association of Inflammation Societies, Aug. 3-7, 2003, Vancouver, Canada.

Kage, A.K., Tinker, M.T., Doak, D.F. 2002. Application of Individual Based Movement Models to Movement Patterns of California Sea Otters (Enhydra lutris nereis). Carnivores 2002 - From the Mountains to the Sea: A Conference on Carnivore Biology and Conservation, Monterey, California.

Leifer, I. 2003. Bubble survival and the fate of Shane Seep methane and oil. Poster presentation, Shallow Hydrocarbon Migration Workshop, Santa Barbara, CA.

Leifer, I. 2002. Marine hydrocarbon seeps: A natural laboratory for studying processes related to petroleum exploration, spill migration, and ecological adaptation. Presented to Pacific Office of the Minerals Management Service, Camarillo, California.

Leifer, I., Boles, J., Clark, J., Holden, P., LaMontagne, M., Luyendyk, B., Olman, C. and L. Washburn. 2002. Predicting the fate of oil in the marine environment from the seadeb to surface oil slicks and beyond. Invited talk, California and the World Oceans '02, Santa Barbara, California.

Lorenson, T., Ussler III, W., Dougherty, J., Paull, C., Mitra, S., Keaten, R., Kvenvolden, K., and I. Leifer. 2002. Dissolved methane concentrations adjacent to natural oil and gas seeps off Pt. Conception, California. AGU. San Fransisco, CA.

Madari, H., Panda, D., Wilson, L., and R.S. Jacobs. 2002. Dicoumarol: A Coumarin Compound with Unique Microtubule Stabilizing Properties. XIVth World congress of Pharmacology (ASPET), July 7-12, 2002, San Francisco. California.

Mydlarz, L. and R.S. Jacobs. 2003. Physiological and ecological significance of terpene synthesis in the symbiotic association of the gorgonian coral *Pseudopterogorgia elisabethae*. American Society of Limnology and Oceanography, Aquatic Sciences Meeting, Feb. 13th, 2003, Salt Lake City, Utah.

Ohlmann, J. C. 2003. Stormwater monitoring with drifters, presented at the Bight '03 Water Quality planning meeting, Westminster, California.

Ohlmann, J. C. and A. L. Sybrandy. 2002. A catch-and-release Lagrangian drifter for near-shore ocean circulation research, presented at California and World Ocean '02, Santa Barbara, California.

Ohlmann, J. C., Sybrandy, A. L. and P. P. Niiler. 2002. A catch-and-release drifter that resolves characteristic scales of coastal dynamics, presented at the Lagrangian Analysis and Prediction of Coastal and Ocean Dynamics conference, Key Largo, Florida.

Page, H.M., Dugan J. E., Culver, C. C., Schroeder, D. M., Bram, J. and B. Mardian. 2003. Patterns of recruitment, distribution, and abundance of Invertebrates and fishes on offshore platforms: relationships to gradients in oceanographic conditions. American Society of Limnology and Oceanography, Salt Lake City, Utah, February 2003.

Raimondi, P. T. 2003. Unexpected dynamism in zonation and abundance revealed by long-term monitoring on rocky shores. Invited seminar, Moss Landing Marine Laboratories, Moss Landing, California.

Raimondi, P. T. 2003. Unexpected dynamism in zonation and abundance revealed by long-term monitoring on rocky shores. Invited talk, Marine Interest Group, San Lius Obsipo, California.

Raimondi, P. T. 2003. Unexpected dynamism in zonation and abundance revealed by long-term monitoring on rocky shores. Monterey Bay National Marine Sanctuary, Monterey, California.

Raimondi, P. T. 2002. Techniques of and lessons from Intertidal Monitoring. Research Activity Panel to Monterey Bay National Marine Sanctuary, Monterey, California.

Readdie, M. 2003. Shifting zones: how species upper limits can vary vertically on rocky shores, 6th International Temperate Reef Symposium, Christchurch, NZ.

Reed, D. C., Holbrook, S. J., Blanchette, C. A., and R. J. Schmitt. 2003. Differential reproductive responses to environmental fluctuating in species with contrasting demographies. Sixth International Temperate Reef Symposium, Christchurch, New Zealand.

Ross, C., Krupper, F., and R.S. Jacobs. 2003. Biochemistry of inducible defense mechanisms in the marine Chlorophyte *Dasycladus vermicularis*. American Society of Limnology and Oceanography, Aquatic Sciences Meeting, Feb. 13th, 2003, Salt Lake City, Utah.

Roy, L. A., Steinert, S., Bay, S., and D. Schlenk. 2002. Dose-response evaluations of piscine biochemical endpoints of PAH exposure by sediment obtained from a natural petroleum seep. *Society of Environmental Toxicology and Chemistry*.

Seruto, C., Steinert, S., and D. Schlenk. 2003. Biochemical responses to non-urban PAH exposure in three Pacific flatfish species. Invited speaker, 12th International Symposium of Pollution Responses in Marine Organisms, Safety Harbor, Florida.

Smith, E. R. A. N. 2002. Support for Offshore Oil and Gas Drilling among the California Public. Poster presentation at the California and the World Ocean ’02 Conference, Santa Barbara, California.

Smith, E. R. A. N. 2002. Trends in Public Support for Offshore Oil and Gas Drilling. Presentation delivered at the Policy Committee meeting of the U.S. Minerals Management Service, Department of the Interior, New Orleans, Louisiana.

*Smith, E. R. A. N. and J. Carlisle. 2001. Confidence in Expert Claims about Environmental Risks. Paper delivered at the annual meeting of the American Association for Public Opinion Research, Montreal, Canada.

*Smith, E. R. A. N. and J. Carlisle. 2001. Postmaterialism vs. Egalitarianism as the Key Environmental Variable. Paper delivered at the annual meeting of the American Political Science Association, San Francisco, California.

Smith, E. R. A. N., Carlisle, J., and K. Michaud. 2002. Trust during an Energy Crisis. Paper delivered at the annual meeting of the American Association for Public Opinion Research, Nashville, Tennessee.

Steinert, S., Streib-Montee, R., Schlenk, D., and L. Roy. 2002. DNA damage in multiple tissues form flatfish exposed to PAH-contaminated sediments. *Society of Environmental Toxicology and Chemistry*.

Tinker, M.T., Doak, D.F. 2002. Southern Sea Otter Demography and Population Analyses. Carnivores 2002 - From the Mountains to the Sea: A Conference on Carnivore Biology and Conservation, Monterey, California.

Washburn, L. 2003. Physical Environment of the Santa Barbara Channel. Invited seminar. Channel Islands National Marine Sanctuary, Santa Barbara, California.

Washburn, L., Beckenbach, E. H., Emery, B. M., and C. J. Bassin. 2003. Recent Results form an HF Radar Array on the South Central California Coast. Third International Radiowave Oceanography Workshop, Venice, Italy.

Wilson, C. M., J. M. Altstatt, P.T. Raimondi, and T.E. Minchinton. 2002. Changes in intertidal community structure following mass mortality of the black abalone, *Haliotis cracherodii*, and implications for abalone recovery. Talk given at the Western Society of Naturalists Meeting, Monterey, California.

* Research presentations given before 2002 not included in previous annual reports

CURRICULUM VITAE

RICHARD F. AMBROSE
Environmental Science and Engineering Program
Department of Environmental Health Sciences
University of California
Los Angeles, CA

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

Education:

B.S.	University of California, Irvine	1975
Ph.D.	University of California, Los Angeles	1982

Positions:

2000-present	Professor, Environmental Science and Engineering Program, Department of Environmental Health Sciences, University of California, Los Angeles
1998-present	Director, Environmental Science and Engineering Program, UCLA
1992-2000	Associate Professor, Environmental Science and Engineering Program, Department of Environmental Health Sciences, UCLA
1991-present	Associate Research Biologist, Marine Science Institute, University of California, Santa Barbara
1985-1991	Assistant Research Biologist, Marine Science Institute, University of California, Santa Barbara
1983-1984	Postdoctoral Fellow, Department of Biological Sciences, Simon Fraser University, Burnaby, B.C., Canada
1982	Visiting Lecturer, Department of Biology, University of California, Los Angeles
1976-1981	Teaching Assistant, Department of Biology, University of California, Los Angeles

Major Research Interests:

- Restoration ecology, especially for coastal marine and estuarine environments
- Development and scientific evaluation of mitigation techniques
- Long-term ecological monitoring
- Development of habitat valuation techniques
- Ecology of artificial and natural reefs
- Ecology of Coastal wetlands and estuaries
- Marine ecology
- Interface between environmental biology and resource management policy

Selected Publications:

Page, H. M., Schroeter, S., Reed, D. C., Ambrose, R. F., Callaway, J., and J. Dixon. Variation in the distribution and abundance of salt marsh vegetation associated with elevation and height of tidal inundation. *Bulletin of the Southern California Academy of Sciences* (in press).

Vance, R.R., R.F. Ambrose, S.S. Anderson, S. MacNeil, T. McPherson, I. Beers and T.W. Keeney. Effects of sewage sludge on the growth of potted salt marsh plants exposed to natural tidal inundation. *Restoration Ecology* (in press)

Shuman, C. S. and R. F. Ambrose. A comparison of remote sensing and ground-based methods for monitoring wetland restoration success. *Restoration Ecology* (in press).

Stein, E.D. and R. F. Ambrose. Cumulative impacts of Section 404 Clean Water Act permitting on the riparian habitat of the Santa Margarita, CA watershed. *Wetlands* (in press)

Forrester, G. E., Fredericks, B. I., Gerdeman, D., Evans, B., Steele, M. A., Zayed, K., Schweitzer, L. E., Suffet, I. H., Vance, R. R., and R. F. Ambrose. 2003. Correspondence between field-measured growth rates of fish from several California estuaries and the inferred toxicity of multiple sediment contaminants. *Marine Environmental Research* **56**: 423-442.

Moeller, A., MacNeil, S. D., Ambrose, R. F., and S. S. Que Hee. 2003. Elements in fish of Malibu Creek and Malibu Lagoon nearLos Angeles, California. *Marine Pollution Bulletin* **46**: 424-429.

Raimondi PT, Wilson CM, Ambrose RF, Engle JM, Minchinton TE. 2002. Continued declines of black abalone along the coast of California: are mass mortalities related to El Nino events? Mar Ecol-Prog Ser 242: 143-152.

Sudol, M.F. and R.F. Ambrose. 2002. The US Clean Water Act and habitat replacement: Evaluation of mitigation sites in Orange County, California. *Environmental Management* **30**: 727-734.

Boyer, K.E., P. Fong, R.R. Vance and R.F. Ambrose. 2001. *Salicornia virginica* in a Southern California salt marsh: seasonal patterns and a nutrient enrichment experiment. *Wetlands* **21** (3): 315-326.

Cohen, T., S.S. Que Hee and R.F. Ambrose. 2001. Comparison of trace metal concentrations in fish and invertebrates in three Southern California wetlands. *Marine Pollution Bulletin* **42**: 224-232.

Downs TJ, Ambrose RF. 2001. Syntropic ecotoxicology: A heuristic model for understanding the vulnerability of ecological systems to stress. *Ecosyst Health* **7**(4): 266-283.

Moeller, A, Ambrose, RF, Hee, SSQ. 2001. A comparison of techniques for preparing fish fillet for ICP-AES multi-elemental analysis and the microwave digestion of whole fish. *Food Addit Contam* **18** (1): 19-29.

Stein, E.D. and R.F. Ambrose. 2001. Landscape-scale analysis and management of cumulative impacts to riparian ecosystems: past, present and future. *Journal of American Water Resources Association* **37**(6): 1597-1614.

Ambrose, R.F. 2000. Wetland mitigation in the United States: Assessing the success of mitigation policies. *Wetlands* (Australia) **19**: 1-27.

Ambrose, R.F. and D.J Meffert. 1999. Fish-assemblage dynamics in Malibu Lagoon, a small, hydrologically altered estuary in southern California. *Wetlands* **19**: 327-340.

Lafferty, K., C. Swift and R.F. Ambrose. 1999. Extirpation and recovery of local populations of the endangered tidewater goby, *Eucyclogobius newberryi*. *Conservation Biology* **13**: 1447-1453.

Stein, E.D. and R. F. Ambrose. 1998. A rapid impact assessment method for use in a regulatory context. *Wetlands* **18**: 379-392.

Ambrose, R.F. 1997. Ecological value in restored coastal ecosystems. Pp. 67-86 in: *Saving the Seas: Values, Scientists, and International Governance,* L.A. Brooks and S.D. VanDeveer, eds. Maryland Sea Grant College, College Park, MD.

Dunaway, M.E., R.F. Ambrose, J. Campbell, J.M. Engle, M. Hill, Z. Hymanson, and D. Richards. 1997. Establishing a Southern California rocky intertidal monitoring network. Pp. 1278-1294. in: *California and the World Ocean '97,* O.T. Magoon, H. Converse, B. Baird, and M. Miller-Henson, eds. American Society of Civil Engineers, Reston, Virginia.

Engle, J.M., R.F. Ambrose, and P.T. Raimondi. 1997. Synopsis of the Interagency Rocky Intertidal Monitory Network Workshop. Final Report, OCS Study MMS 97-0012. U.S. Minerals Management Service, Pacific OCS Region. 18p.

Palmer, M.A., N.L. Poff, and R.F. Ambrose. 1997. Ecological theory and community restoration ecology. *Restoration Ecology* **5:** 291-300.

ANDREW J. BROOKS
Department of Ecology, Evolution and Marine Biology
University of California
Santa Barbara, CA

Projects: *Population Trends and Trophic Dynamics in Pacific OCS Ecosystems: What Can Monitoring Data Tell Us?*
Relative importance of POCS oil platforms on the population dynamics of two reef fishes in the Eastern Santa Barbara Channel

Education:

B.A.	Biology with Marine Emphasis, Occidental College	1984
Certificate	Aquatic Biology and Fisheries Management, University College of North Wales, U.K.	1987
M.A.	Biological Sciences, University of California, Santa Barbara	1993
Ph.D.	Ecology, Evolution and Marine Biology, University of California, Santa Barbara	1999

Positions:

2001-Present	Director, Carpinteria Salt Marsh Reserve, University of California
1999-Present	Assistant Research Biologist, Marine Science Institute, University of California, Santa Barbara
1998-Present	Lecturer, Dept. of Ecology, Evolution and Marine Biology, University of California, Santa Barbara
1998-1999	Post-Doctoral Researcher, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara
1998	Teaching Associate, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara
1990-1998:	Research Assistant, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara
1988-89	Instructor, Department of Physics, Los Angeles Valley College
1988-91	Instructor, Department of Biology, Occidental College
1987-89	Marine Ecologist and Project Leader, Vantuna Research Group, Occidental College
1984-86	Marine Ecologist, Vantuna Research Group, Occidental College

Grants and Awards:

2002-2005	W.M. Keck Foundation
2002-2004	Minerals Management Service CMI Project Award
2001-2004	US Environmental Protection Agency
2001	Member, American Institute of Fishery Research Biologists
1997-2001	Minerals Management Service CMI Project Award
1997	University Award of Distinction, University of California, Santa Barbara
1995-1999	UC TSR&TP Fellowship, University of California, Santa Barbara
1994-1996	Mildred Mathias Grant, University of California, Santa Barbara
1994-1996	Crocker Grant
1994-1995	Continuing Graduate Student Fellowship, University of California, Santa Barbara

Selected Publications:

Brooks, A. J., Schmitt, R. J., and S. J. Holbrook. 2003. Parallel changes observed across several trophic levels suggest a common response by marine communities to short-term climate change. *Ecology Letters* (in prep).

Swearer, S. E., Forrester, G.E., Steele, M.A., Brooks, A.J., and D.W. Lea. 2003. Spatio-temporal and interspecific variation in otolith trace-elemental fingerprints in a temperate estuarine fish assemblage. *Estuarine, Coastal and Shelf Science* (in press).

Holbrook, S.J., Brooks, A.J., and R. J. Schmitt. 2002. Are fish assemblages on coral patch reefs predictable? *Marine and Freshwater Research* **53** (2):181-188.

Brooks, A.J., Schmitt, R.J., and S. J. Holbrook. 2002. Declines in regional fish populations: have different species responded similarly to environmental change? *Marine and Freshwater Research* **53** (2):189-198.

Holbrook, S.J., Brooks, A.J., and R. J. Schmitt. 2002. Variation in structural attributes of patch forming corals and in patterns of abundance of associated fishes. *Marine and Freshwater Research* **53** (7):1045-1053.

Brooks, A.J. 1999. Factors Influencing the Structure of an Estuarine Fish Community: The Role of Interspecific Competition. Ph.D. Dissertation. University of California, Santa Barbara, 219 pp.

Nisbet, R.M., Muller, E.B., Brooks, A.J., and P. Hosseini. 1997. Models relating individual and population response to contaminants. *Environmental Modeling and Assessment* **2**: 7-12.

Love, M.S., Brooks, A.J., and J.R.R. Ally. 1996. An analysis of the commercial passenger fishing vessel fisheries for kelp and barred sand basses (*Paralabrax clathratus* and *P. nebulifer*) in the Southern California Bight. *California Fish and Game* **82**: 105-121.

Nisbet, R.M., Ross, A.H., and A.J. Brooks. 1996. Empirically-based dynamic energy budget models: theory and an application to ecotoxicology. *Nonlinear World* **3**: 85-106.

Love, M.S., Brooks, A.J., Busatto, D., Stephens Jr., J., and P. Gregory. 1996. Aspects of the life histories of the kelp bass and barred sand bass (*Paralabrax clathratus* and *P. nebulifer*) from the Southern California Bight. *Fisheries Bulletin* **94**: 472-481.

Love, M.S., Hyland, J., Ebeling, A., Herrlinger, T., Brooks, A.J., and E. Imamura. 1994. A pilot study of the distribution and abundance of rockfishes in relation to natural environmental factors and an offshore oil and gas production platform off the coast of Southern California. *Bulletin Marine Science* **55**: 1062.-1085.

Love, M.S. and A.J. Brooks. 1990. Size and age at first maturity of the California halibut, *Paralichthys californicus*, in the Southern California Bight. Pp. 167-174 in: *The California halibut*, *Paralichthys californicus, resource and fisheries.* California Fish and Game Fisheries Bulletin.

Love, M.S., Axell, B., Morris, P., Collins, R., and A.J. Brooks. 1987. Life history and fishery of the California scorpionfish, *Scorpaena guttata*, within the Southern California Bight. *Fisheries Bulletin* **85**: 99-116.

Brooks, A.J. 1987. Two species of Kyphosidae seen in King Harbor, Redondo Beach, California. *California Fish and Game* **73**: 49-61.

DOUGLAS S. BUSH
Marine Science Institute
University of California
Santa Barbara, CA

Project: *Population Genetics of Surfgrass (Phyllospadix torreyi) for Use in Restoration*

Education:	B.A.	Botany, University of Hawaii	1974
	M.S.	Plant Physiology, UC Berkeley	1979
	Ph.D.	Plant Physiology, UC Berkeley	1983

Positions:	1998-Present	Associate Research Biologist, Marine Science Institute, UC Santa Barbara
	1998-Present	Adjunct Associate Professor, Dept. of Ecology, Evolution, and Marine Biology, UC Santa
	1990-1997	Assistant/Associate Professor, Rutgers University, Dept. of Biological Sciences
	1989-1990	Assistant Research Botanist, UC Berkeley, Dept. of Botany
	1984-1989	Postdoctoral Associate, UC Berkeley, Dept. of Botany
	1979-1983	Research Associate, UC Berkeley, Dept. of Plant and Soil Biology
	1977-1979	Statistician, UC Berkeley, Dept. of Plant and Soil Biology

Research Interests:
Genetics of natural plant populations, Evolutionary Genetics, Plant cell biology, cell calcium and transduction of hormonal signals. Membrane transport events induced by plant growth regulators. Programmed cell death.

Awards: Henry Rutgers Fellow, 1990
EMBO Workshop Fellowship, Patch Clamp Techniques, Göttingen, West Germany, 1987
Presidents Fellowship, University of California, Berkeley, 1980-1981

Selected Publications:

Rodriguez, M.T. and D.S. Bush. 1999. Gibberellin-induced cell death in the wheat aleurone. *Plant Physiology* (submitted).

Silverman, P., Assiahmah, A., and D.S. Bush. 1998. Cytokinin action in root hairs of *Medicago sativa*. *Planta* **205**: 25-31.

Subbaiah, C., Bush, D.S., and M. Sachs. 1998. Mitochondria contribution to the anoxic Ca^{2+} signal in maize suspension-cultured sells. *Plant Physiology* **118**: 759-771.

Thompson, M.D., Bush, D.S., and L.E. Bello. 1997. Possible Wilson's disease: A case presentation. *Arch Clin Neuropsych* **12**(4): 416-416.

Bush, D.S. 1996. Effects of gibberellic acid and environmental factors on cytosolic calcium in wheat aleurone cells. *Planta*. **199**: 89-99.

Kuo, A., Cappellutti, S., Cervantes-Cervantes, M., Rodriquez, M., and D.S. Bush. 1996. Okadaic acid, a protein phosphatase inhibitor, blocks calcium changes, gene expression and cell death induced by gibberellin in wheat aleurone. *The Plant Cell* **8**: 259-269.

Rodriguez, M.T. and D.S. Bush. 1996. Programmed cell death and hormonal responses in wheat aleurone cells. *Mol Biol Cell* **7**: 2015-2015 Suppl. S.

Silverman, F.P. and D.S. Bush. 1996. Membrane transport and cytokinin action in alfalfa root hairs. *Mol Biol Cell* **7**: 1761-1761 Suppl. S.

Bush, D.S. 1995. Calcium regulation in plant cells and its role in signaling. *Annu. Rev. Plant Physiology. Plant Molecular Biology* **46**: 95-122.

Bush, D.S. and T. Wang. 1995. Diversity of calcium efflux transporters in wheat aleurone cells. *Planta*. **197**:19-30.

Cervantes-Cervantes, M., Cappelluti, S.J., and D.S. Bush. 1995. Identification of Plant Ca^{2+} Transport Proteins by Complementation in Yeast. *Plant Physiol* **108**(2): 37-37 Suppl. S.

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Subbaiah, C., Bush, D.S., and M. Sachs. 1994. Elevation of cytosolic calcium precedes anoxic gene expression in maize suspension-cultured cells. *The Plant Cell* **6**:1747-1762.

Bush, D.S. 1993. Regulation of cytosolic calcium in plants. *Plant Physiology* **103**: 7-13.

Bush, D.S., Biswas, A.K., and R.L. Jones. 1993. Hormonal regulation of Ca^{2+}-transport in the endomembrane system of the barley aleurone. *Planta* **189**: 507-515.

Bush, D.S. 1992. The role of Ca^{2+} in the action of GA in the barley aleurone. In: CM Karssen, LC Van Loon, and D Vreugdenhil, eds. "Progress in plant growth regulation: Proceedings of the 14th International conference on plant growth substances, Amsterdam, 21-26 July, 1991." pp. 96-104. Kluwer Academic Pub., Dordrecht, The Netherlands.

Drøbak, B.K., Bush, D.S., Jones, R.L., Dawson, A.P., and I.B. Ferguson. 1992. Analysis of calcium involvement in host-pathogen interactions. In: Gurr, S.J., M.J. McPherson, and D.J. Bowles eds. "Molecular Plant Pathology: A Practical Approach". Vol. II, pp. 159-194. IRL Press at Oxford University Press, Cambridge.

Arnalte, M.E., Cornejo, M.J., Bush, D.S., and R.L. Jones. 1991. The effect of gibberellic acid on the lipid composition of barley aleurone protoplasts. *Plant Science* **77**: 223-232.

Bush, D.S., Sticher, L., and R.L. Jones. 1991. Gibberellic acid-regulated α-amylase synthesis and calcium transport in the endoplasmic reticulum of barley aleurone cells. In: "Gibberellins: Tokyo 1989". pp. 106-113.

Jones, R.L. and D.S. Bush. 1991. Gibberellic acid and abscisic acid regulate the level of a BiP cognate in the endoplasmic reticulum of barely aleurone cells. *Plant Physiology* **97**: 456-459.

Jones, R.L., Sticher, L., and D.S. Bush. 1991. Secretion of hydrolases from cereal aleurone cells. In: Hawes, C., J. Coleman and D. Evans, eds. "Endocytosis, Exocytosis and Vesicle Traffic in Plants", Cambridge University Press, Cambridge.

Bush, D.S. and R.L. Jones. 1990. Hormonal Regulation of Ca^{2+} transport in microsomal vesicles isolated from barley aleurone layers. Calcium in plant growth and development. Leonard and Hepler eds. *American Society of Plant Physiologists* **4**: 60-65.

Bush, D.S. and R.L. Jones. 1990. Measuring intracellular Ca^{2+} levels in plant cells using the fluorescent probes, indo-1 and fura-2: progress and prospects. *Plant Physiology* **93**: 841-845.

DuPont, F.M., Bush, D.S., Windle, J.J., and R.L. Jones. 1990. Calcium and proton transport in membrane vesicles from barley roots. *Plant Physiol.* **94**: 179-188.

Hillmer, S., Bush, D.S., Robinson, D.G., Zingen-Sell, I., and R.L. Jones. 1990. Endomembrane structure and function in barley aleurone protoplasts. *Eur. J. Cell Biol.* **52**: 169-173.

Sticher, L., Biswas, A.K., Bush, D.S., and R.L. Jones. 1990. Heat shock inhibits α-amylase synthesis in barley aleurone without inhibiting the activity of endoplasmic reticulum marker enzymes. *Plant Physiol.* **92**: 506-513.

MARK H. CARR
Department of Biology
University of California
Santa Cruz, CA

Project: *Ecological Consequences of Alternative Abandonment Strategies for POCS Offshore Facilities and Implications for Policy Development*

Education	B.A.	Biology, University of California, Santa Cruz	1976
	M.S.	San Francisco State University	1983
	Ph.D.	University of California, Santa Barbara	1991

Positions:	1997-present	Assistant Professor III, Department of Biology, University of California, Santa Cruz, CA.
	1994-1997	Assistant Research Biologist IV, Deputy Director, SCEI and CMI, Marine Science Institute, University of California, Santa Barbara, CA.
	1992-94	Post-doctoral Research Associate, Department of Zoology, Oregon State University
	1993-94	Lecturer, Department of Zoology, Oregon State University
	1984-1991	Graduate Research Assistant, Department of Biological Sciences, University of California, Santa Barbara
	1981-1983	Research Technician, California Institute of Technology

Distinctions:	1989	Outstanding Student Paper Award, Western Society of Naturalists
	1988	EPRI Fellowship, Sport Fishing Institute
	1987	Joseph Drown Fellowship, University of Southern California, Oceanographic Associates

Research Interests:

- Population and community ecology of marine reef fishes
- Application of behavioral and ecological research to marine fisheries and conservation problems.

Selected Publications:

Carr, M.H. and C. Syms. "Recruitment: the replenishment of demersal fish populations" chapter *In:* Allen, L. (ed.) *The Ecology of California Marine Fishes*. U.C. Press. (in press)

Carr, M.H., Neigel, J.E., Estes, J.A., Andelman, S.J., Warner, R.R., and J.L. Largier. Comparing marine and terrestrial ecosystems: implications for principles of reserve design in coastal marine ecosystems. *Ecological Applications* (in press)

Shanks, A.L., Grantham, B., and M.H. Carr. Propagule dispersal distance and the size and spacing of marine reserves. *Ecological Applications* (in press)

Anderson, T.W., Bartels, C.T., Hixon, M.A., Bartels, E., Carr, M.H., and J.M. Shenker. 2002. Current flow and catch efficiency in sampling settlement-stage larvae of coral-reef fishes. *Fishery Bulletin* **100**: 404-413.

Carr, M.H. and C. Syms. 2002. Marine reserves in the Monterey Bay National Marine Sanctuary: what we do and don't know. Pp. 51-72 *In*: Starr, R.M., M.H. Carr, J. Caselle, J.A. Estes, C. Pomeroy, C. Syms, D, VenTresca, and M.M. Yoklavich. A review of the ecological effectiveness of subtidal marine reserves in Central California. Part I: Synopsis of scientific investigations. A Report to the Monterey Bay National Marine Sanctuary.

Carr, M.H., Anderson, T.W., and M.A. Hixon. 2002. Biodiversity, population regulation, and the stability of coral-reef fish communities. *Proceedings of the National Academy of Sciences* **99**: 11241-11245.

Starr, R.M., Carr, M.H., Caselle, J., Estes, J.A., Pomeroy, C., Syms, C., VenTresca, D., and M.M. Yoklavich. 2002. A review of the ecological effectiveness of subtidal marine reserves in Central California. Part II: Summary of existing marine reserves in Central California and their potential benefits. A Report to the Monterey Bay National Marine Sanctuary.12 pp.

Steele, M.A., Malone, J.C., Findlay, A.M., Carr, M.H., and G.E. Forrester. 2002. A simple method for estimating larval supply in reef fishes and a preliminary test of population limitation by larval delivery in the kelp bass, *Paralabrax clathratus*. *Marine Ecology Progress Series* **235**: 195-203.

Syms, C. and M.H. Carr. 2002. International Clearinghouse for MPA Effectiveness Measures: a Conceptual Design. Report prepared for the North American Commission for Environmental Cooperation.

Carr, M.H. 2000. Marine protected areas: challenges and opportunities for understanding and conserving coastal marine ecosystems. *Environmental Conservation* **27**: 106-109.

Carr, M.H. and A.A. Ammann. 2000. Contrasting effects of La Nina and El Nino on recruitment of juvenile rockfishes. Ecosystem Observations, Monterey Bay National Marine Sanctuary: 11-12.

Holbrook, S.J., Ambrose, R.F., Botsford, L., Carr, M.H., Raimondi, P.T., and M.J. Tegner. 2000. Ecological Issues Related to Decommissioning of California's Offshore Production Platforms. A Report to the University of California Marine Council by The Select Scientific Advisory Committee on Decommissioning, University of California.

Reed, D.C., Raimondi, P.T., Carr, M.H., and L. Goldwasser. 2000. The role of dispersal and disturbance in determining spatial heterogeneity in sedentary kelp-forest organisms. *Ecology* **81**: 2011-2026.

Carr, M.H. and P.T. Raimondi. 1999. Marine protected areas as a precautionary approach to management. *California Cooperative Oceanic Fisheries Investigations Reports* **40**: 71-76.

Murray, S.N., Ambrose, R.F., Bohnsack, J.A., Botsford, L.W., and M.H. Carr. 1999. No-take reserve networks: sustaining fishery populations and marine ecosystems. *Fisheries* **24**: 11-25

Allison, G., Lubchenco, J., and M.H. Carr. 1998. Marine reserves are necessary but not sufficient for marine conservation. *Ecological Applications* **8**: S79-S92.

Anderson, T.W. and M.H. Carr. 1998. BINCKE: A highly efficient net for collecting reef-associated fishes. *Environmental Biology of Fishes* **51**: 111-115.

Carr, M.H. 1998. Effects of spatial structure on the relationship between larval supply, habitat availability and recruitment of reef fishes. pp. 215-218 *In:* Jones, G.P., Doherty, P.J., Mapstone, B.D., and Howlett, L. (eds.) *ReeFish '95: Recruitment and Population Dynamics of Coral Reef Fishes*. CRC Reef Research Centre, Townsville, Australia, 297 pp.

Carr, M.H. and P.T. Raimondi. 1998. Concepts relevant to the design and evaluation of harvest reserves. *In*: Proceedings of the Marine Harvest Refugia for West Coast Rockfish: A Workshop. M. Yoklavich, ed. *NOAA-NMFS Technical Memo* SWFC-255, pp. 27-31.

Carr, M.H., Hourigan, T., Ito, D., McArdle, D., Morgan, L., Palsson, W., Parrish, R., Ralston, S., Reilly, P., Sladek, J., and R. Starr. 1998. "Working group on design considerations" pp. 143-148 *In:* M.M. Yoklavich (ed.) Marine Harvest Refugia for West Coast Rockfish: A Workshop. *NOAA/NMFS Technical Memo* SWFC-255.

Caley, M.J., Carr, M.H., Hixon, M.A., Hughes, T.P., Jones, G.P., and B.A. Menge. 1997. Recruitment and the population dynamics of open marine populations. *Annual Review of Ecology and Systematics* **27**: 477-500.

Carr, M.H. and M.A. Hixon. 1997. Artificial reefs: the importance of comparisons with natural reefs. *Fisheries* **22**: 28-33.

JAMES J. CHILDRESS
Department of Ecology, Evolution and Marine Biology
University of California
Santa Barbara, CA

Project: *Habitat Value of Shell Mounds to Ecologically and Commercially Important Benthic Species*

Education:	B.A.	Biological Sciences, Wabash College	1964
	Ph.D.	Physiology, Stanford University	1969

Positions: 1969-present Professor, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, California.

Selected Publications:

Girguis, P.R., Childress, J.J., Freytag, J.K., Klose, K., and R. Stuber. 2002. Effects of metabolite uptake on proton-equivalent elimination by two species of deep-sea vestimentiferan tubeworm, *Riftia pachyptila* and *Lamellibrachia cf luymesi*: proton elimination is a necessary adaptation to sulfide-oxidizing chemoautotrophic symbionts. *J Exp. Biol.* **205**(19): 3055-3066.

Freytag, J.K., Girguis, P.R., Bergquist, D.C., Andras, J.P., Childress, J.J., and C.R. Fisher. 2001. A paradox resolved: Sulfide acquisition by roots of seep tubeworms sustains net chemoautotrophy. *P Natl. Acad. Sci. USA* **98**(23): 13408-13413.

Goffredi, S.K., and J.J. Childress. 2001. Activity and inhibitor sensitivity of ATPases in the hydrothermal vent tubeworm *Riftia pachyptila*: a comparative approach. *Mar. Biol.* **138**(2): 259-265.

Chevaldonne, P., Fisher, C.R., Childress, J.J., Desbruyeres, D., Jollivet, D., Zal, F., and A. Toulmond. 2000. Thermotolerance and the 'Pompeii worms'. *Mar. Ecol. Prog. Ser.* **208**: 293-295.

Girguis, P.R., Lee, R.W., Desaulniers, N., Childress, J.J., Pospesel, M., Felbeck, H., and F. Zal. 2000. Fate of nitrate acuired by the tubeworm *Riftia pachyptila*. *Applied and Environmental Microbiology* **66**: 2783-2790.

Janssens, B.J., Childress, J.J., Baguet, F., Rees, J.F. 2000. Reduced enzymatic antioxidative defense in deep-sea fish. *J Exp. Biol.* **203**(24): 3717-3725.

Seibel, B.A. and J.J. Childress. 2000. Metabolism of benthic octopods (Cephalopoda) as a function of habitat depth and oxygen concentration. *Deep-Sea Res. PT I* **47**(7): 1247-1260.

Seibel, B.A., Thuesen, E.V., and J.J. Childress. 2000. Light-limitation on predator-prey interactions: Consequences for metabolism and locomotion of deep-sea cephalopods. *Biol. Bull.* **198**(2): 284-298.

Zal, F., Green, B.N., Martineu, P., Lallier, F.H., Toulmond, A., Vinogradov, S.N., and J.J. Childress. 2000. Polypeptide chain composition diversity of hexagonal-bilayer haemoglobins within a single family of annelids, the Alvinellidae. *Eur. J. Biochem.* **267**(16): 5227-5236.

Zal, F., Leize, E., Oros, D.R., Hourdez, S., Van Dorsselaer, A., and J.J. Childress. 2000. Haemoglobin structure and biochemical characteristics of the sulphide-binding component from the deep-sea clam *Calyptogena magnifica* . *Cah Biol Mar* **41**(4): 413-423.

Goffredi, S.K., Childress, J.J., Lallier, F.H., and N.T. Desaulniers. 1999. The internal ionic composition of the hydrothermal vent tubeworm Riftia pachyptila; evidence for the accumulation of SO_4^{2-} and H^+ and for a Cl^- /HCO^{3-} shift. *Physiol. and Biochem. Zool.* **72**: 296-306.

Goffredi, S.K., Girguis, P.R., Childress, J.J., and N.T. Desaulniers. 1999. The physiological functioning of carbonic anhydrase in the hydrothermal vent tubeworm *Riftia pachyptila*. *Biol. Bull.* **196**: 257-264.

Shillito, B., Ravaux, J., Gaill, F., Delachambre, J., Thiebaut, E., and J.J. Childress. 1999. Preliminary data on carbon production of deep-sea vent tubeworms. *Mar. Ecol. Prog. Ser.***183**: 275-279.

Childress, J.J. and B.A. Seibel. 1998. Life at stable low oxygen: Adaptations of animals to oceanic oxygen minimum layers. *J. Exp. Biol.* **201**: 1223-1232.

Girguis, P.R. and J.J. Childress. 1998. H+ equivalent elimination by the tube-worm *Riftia pachyptila*. *Cah Biol Mar* **39**(3-4): 295-296.

Goffredi, S.K., Childress, J.J., Lallier, F.H., and N.T. Desaulniers. 1998. How to be the perfect host: CO_2 and HS^- accumulation and H^+ elimination in the hydrothermal vent tube-worm *Riftia pachyptila*. *Cah Biol Mar* **39**(3-4): 297-300.

Ravaux, J., Shillito, B., Gaill, F., Gay, L., Voss-Foucart, M.F., and J.J. Childress. 1998. Tube synthesis and growth processes in the hydrothermal vent tube-worm *Riftia pachyptila*. *Cah Biol Mar* **39**(3-4): 325-326.

Thuesen, E.V., Miller, C.B., and J.J. Childress. 1998. Ecophysiological interpretation of oxygen consumption rates and enzymatic activities of deep-sea copepods. *Marine Ecology Progress Series* **168**: 95-107.

Zal, F., Leize, E., Lallier, F.H., Toulmond, A., Dorsselaer, A.V., and J.J. Childress. 1998. S-sulfohemoglobin and disulfide-exhange: The mechanisms of sulfide-binding by *Riftia pachyptila* hemoglobins. *P.N.A.S.* **95**: 8997-9002.

Goffredi, S.K., Childress, J.J., Desaulniers, N.T., and F.H. Lallier. 1997. Sulfide uptake by the hydrothermal vent tubeworm *Riftia* is via diffusion of HS^-, rather than H_2S. *J. Exp. Biol.* **200**: 2609-2616.

Goffredi, S.K., Childress, J.J., Desaulniers, N.T., Lee, R.W., Lallier, F.H., and D. Hammond. 1997. Inorganic carbon acquisition by hydrothermal vent tubeworm *Riftia pachyptila* depends upon high external PCO_2 and on proton equivalent ion transport by the worm. *J. Exp. Biology* **200**: 883-896.

Seibel, B.A., Thuesen, E.V., Childress, J.J., and L.A. Gorodezky. 1997. Decline in pelagic cephalopod metabolism with habitat depth reflects changes in locomotory efficiency. *Bio Bull.* **192**: 262-278.

Childress, J.J. 1995. Are there physiological and biochemical adaptations of metabolism in deep-sea animals? *Trends in Ecology and Evolution* **10**: 30-36.

Lee, R.W. and J.J. Childress. 1994. Assimilation of inorganic nitrogen by marine invertebrates and their chemoautotrophic and methanotrophic symbionts. *Applied and Environmental Microbiology* **60**: 1852-1858.

Childress, J.J., Fisher, C.R., Favuzzi, J.A., Arp, A.J., and D.R. Oros. 1993. The role of a zinc-based, serum-borne sulphide-binding component in the uptake and transport of dissolved sulphide by the chemoautotrophic symbiont containing clam *Calyptogena elongate. J. exp. Biology* **179**: 131-158.

Childress, J.J., Lee, R.W., Sanders, N.K., Felbeck, H., Oros, D., Toulmond, A., Desbruyères, D., Brooks, J., and M.C. Kennicutt II. 1993. Inorganic carbon uptake in hydrothermal vent tubeworms facilitated by high environmental pCO_2. *Nature* **362**: 147-149.

Childress, J.J. and C.R. Fisher. 1992. The biology of hydrothermal vent animals: physiology, biochemistry, and autotrophic symbioses. *Oceanography and Marine Biology: an Annual Review* **30**: 337-441.

Childress, J.J., Fisher, C.R., Favuzzi, J.A., Kochevar, R., Sanders, N.K., and A.M. Alayse. 1991. Sulfide-driven autotrophic balance in the bacterial symbiont-containing hydrothermal vent tubeworm *Riftia pachyptila*, Jones. *Biological Bulletin* **180**: 135-153.

Sanders, N.K. and J.J. Childress. 1990. Adaptations to the deep-sea oxygen minimum layer: Oxygen binding by the hemocyanin of the bathypelagic mysid, *Gnathophausia ingens* Dohrn. *Biol. Bull.* **178**: 286-294.

JORDAN CLARK
Department of Geological Sciences
Program of Environmental Studies
University of California
Santa Barbara, CA

Projects: *Simulation of a Subsurface Oil Spill by a Hydrocarbon Seep (SSOS-HYS).*
Oil Slicks in the Ocean: Predicting their Release PointsUsing the Natural Laboratory of the Santa Barbara Channel.

Education:	B.S.	Yale University, New Haven, Connecticut	1988
	M.A.	Columbia University, New York City, New York	1991
	Ph.D.	Columbia University, New York City, New York	1995

Positions:	1996-present	Assistant Professor, Dept. of Geological Sciences and Program of Environmental Studies, University of California, Santa Barbara
	1995 -1996	Post-doctoral Fellowship, Isotope Hydrology Group, Lawrence Livermore National Laboratory
	1989-1995	Graduate Research Assistant, Columbia University

Selected Publications:

Aeschbach-Hertig, W., Stute, M., Clark, J.F., Reuter, R., and P. Schlosser. 2002. A paleotemperature record derived from dissolved noble gases in groundwater of the Aquia Aquifer (Maryland, USA). *Geochimica et Cosmochimica Acta* **66**: 797-817.

Boles, J.R., Clark, J.F., Leifer, I., and L. Washburn. 2002. Temporal variation in natural methane seep rate due to tides, Coal Oil Point area, California. *Journal of Geophysical Research* **106**: 27,077-27,086.

Rademacher, L.K., Clark, J.F., and G.B. Hudson. 2002. Temporal changes in stable isotope composition of spring waters: Implications for recent changes in climate and atmospheric circulation. *Geology* **20**: 139-142.

Clark, J.F. and G.B. Hudson. 2001. Tracing hydrothermal fluids in hypersaline Mono Lake using helium isotopes. *Limnology and Oceanography* **46**: 189-196.

Gamlin, J.D., Clark, J.F., Woodside, G., and R. Herndon. 2001. Tracing groundwater flow patterns in an area of artificial recharge using sulfur hexafluoride. *Journal of Environmental Engineering ASCE* **127**: 171-174.

Radamacher, L.K., Clark, J.F., Hudson, G.B., Erman, D.C., and N.A. Erman. 2001. Chemical evolution of shallow groundwater as recorded by springs, Sagehen basin, Nevada County California. *Chemical Geology* **179**: 37-51.

Clark, J.F., Washburn, L., Hornafius, J.S., and B.P. Luyendyk. 2000. Dissolved hydrocarbon flux from natural marine seeps to the southern California Bight. *Journal of Geophysical Research* 105 (11): 509-11,522.

Leifer, I., Clark, J.F., and R.F. Chen. 2000. Modifications of the local environment by natural marine hydrocarbon seeps. *Geophysical Research Letters* **27**: 3711-3714.

Macfarlane, P.A., Clark, J.F., Davisson, M.L., Hudson, G.B., and D.O. Whittemore. 2000. Late Quaternary ground water recharge in the central Great Plains from geochemical tracers in shallow ground water. *Quaternary Research* **53**: 167-174.

Quigley, D.C., Hornafius, J.S., Luyendyk, B.P., Francis, R.D., Clark, J.F., and L. Washburn. 1999. Decrease in natural marine hydrocarbon seepage near Coal Oil Point, California associated with offshore oil production. *Geology* **27**: 1047-1050.

Aeschbach-Hertig, W., Schlosser, P., Stute, M., Simpson, H.J., Ludin, A., and J.F. Clark. 1998. A $^{3}H/^{3}He$ study of groundwater flow in a fractured bedrock aquifer. *Ground Water* **36**: 661-670.

Clark, J.F, Davisson, M.L., Hudson, G.B., and P.A. Macfarlane. 1998. Noble gases, stable isotopes, and radiocarbon as tracers of flow in the Dakota aquifer, Colorado and Kansas. *Journal of Hydrology* **211**: 151-167.

Clark, J.F., Stute, M., Schlosser, P., Drenkard, S., and G. Bonani. 1997. An isotope study of the Floridan aquifer in Southeastern Georgia: Implications for groundwater flow and paleoclimate. *Water Resources Research* **33**: 281-289.

Macfarlane, P.A., Clark, J.F., Whittemore, D.O., Davisson, M.L., and G.B. Hudson. 1997. Holocene and late Pleistocene climate conditions in the central Great Plains deduced from noble gases, stable isotopes, Cl, and ^{36}Cl in shallow groundwater. Kansas Geological Survey Open-File-Report #97-77, 28 p.

Clark, J.F., Schlosser, P., Stute, M., and H.J. Simpson. 1996. SF_6 - ^{3}He tracer release experiment: A new method of determining longitudinal dispersion coefficients in large rivers. *Environmental Science and Technology* **30**: 1527-1532.

Clark, J.F., Schlosser, P., Simpson, H.J., Stute, M., Wanninkhof, R., and D.T. Ho. 1995. Relationship between gas transfer velocities and wind speeds in the tidal Hudson River determined by the dual tracer technique. In: *Air-Water Gas Transfer*, eds. Jähne, B. and E. Monahan, Aeon Verlag, Hanau, 785-800.

Clark, J.F., Schlosser, P., Wanninkhof, R., Simpson, H.J., Schuster, W.S.F., and D.T. Ho. 1995. Gas transfer velocities for SF_6 and ^{3}He in a small pond at low wind speeds. *Geophysical Research Letters* **22**: 93-97.

Clark, J.F., Simpson, H.J., Bopp, R.F., and B. Deck. 1995. Dissolved oxygen in lower Hudson estuary: 1978-93. *Journal of Environmental Engineering, ASCE*. **121**: 760-763.

Clark, J.F., Smethie Jr., W.M., and H.J. Simpson. 1995. Chlorofluorocarbons in the Hudson estuary during summer months. *Water Resources Research* **31**: 2553-2560.

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Clark, J.F., Wanninkhof, R., Schlosser, P., and H.J. Simpson. 1994. Gas exchange in the tidal Hudson River using a dual tracer technique. *Tellus* **46B**: 274-285.

Stute, M., Clark, J.F., Phillips, F.M., and D. Elmore. 1993. Reconstruction of late glacial climates from the groundwater archive: Cl and ^{36}Cl in the Carrizo aquifer, Texas. *Applications of Isotope Techniques in Studying Past and Current Environmental Changes in the Hydrosphere and the Atmosphere*, IAEA, Vienna, 259-270.

Clark, J.F., Simpson, H.J., Bopp, R.F., and B. Deck. 1992. Geochemistry and loading history of phosphate and silicate in the Hudson estuary. *Estuarine, Coastal and Shelf Science* **34**: 213-233.

Clark, J.F., Simpson, H.J., Smethie Jr., W.M., and C. Toles. 1992. Gas exchange in a contaminated estuary inferred from chlorofluorocarbons. *Geophysical Research Letters* **19**: 1133-1136.

Stute, M., Schlosser, P., Clark, J.F., and W.S. Broecker. 1992. Paleotemperatures in the southwestern United States derived from noble gas measurements in groundwater. *Science* **256**: 1000-1003.

DANIEL P. COSTA
Department of Ecology and Evolutionary Biology
University of California
Santa Cruz, CA

Project: *Population Dynamics and Biology of the California Sea Otter at the Southern End of its Range*

Education:	B.A.	Zoology, University of California, Los Angeles	1974
	Ph.D.	Biology, University of California, Santa Cruz	1977

Positions:	1996	Elected Fellow of the California Academy of Sciences
	1995-Present	Associate Director of the Institute of Marine Sciences, University of California, Santa Cruz, CA
	1995-Present	Editorial Board of Physiological Zoology
	1993-Present	Professor of Biology, University of California, Santa Cruz, CA
	1991-1993	Associate Professor of Biology, University of California, Santa Cruz, CA
	1991-1993	Scientific Officer, Physiology and Marine Mammal Biology, Office of Naval Research
	1987 & 1989	ASEE Senior Faculty Fellow, NOSC, US Navy, Hawaii
	1985 & 1987	Visiting Scientist, British Antarctic Survey, Cambridge, England
	1979-1982	National Institutes of Health Postdoctoral Fellowship, Scripps Institution of Oceanography, San Diego, CA

Selected Publications:

Shaffer, S.A., Costa, D.P., and H. Weimerskirch. 2001. Behavioural factors affecting foraging effort of breeding wandering albatrosses. *J. of Animal Ecology* **70**: 864-874.

Shaffer, S.A., Costa, D.P., and H. Weimerskirch. 2001. Comparison of methods for evaluating energy expenditure of incubating wandering albatrosses. *Physiological and Biochemical Zoology* **74**: 823-831.

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Burgess, W., Tyack, P., Le Boeuf, B.J., and D.P. Costa. 1998. An intelligent acoustic recording tag first results from free-ranging northern elephant seals. *Deep Sea Research II* **45**: 1327-1351.

Costa, D.P. 1998. The ATOC Consortium. Ocean Climate Change: Comparison of Acoustic Thermography, Satellite Altimetry and Modeling. *Science* **281**: 1327-1332.

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Crocker, D.E., LeBoeuf, B.J., and D.P. Costa. 1996. Drift Diving in female northern elephant seals: Implications for food processing. *Canadian Journal Zoology* **75**: 27-39.

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Ortiz, R., Adams, S.H., Costa, D.P., and C.L. Ortiz. 1996. Plasma vasopressin levels and water conservation in fasting, post-weaned northern elephant seal pups (*Mirounga angustirostris*). *Marine Mammal Sciences* **12**(1): 99-106.

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Costa, D.P. 1993. The relationship between reproductive and foraging energetics and the evolution of the Pinnipedia. *Symposium Zoological Society of London*, Oxford University Press **66**: 293-314.

Costa, D.P. 1991. Reproductive and foraging energetics of high latitude penguins, albatrosses and pinnipeds: Implications for life history patterns. *American Zoologist*. **31**: 111-130.

Costa, D.P. 1991. Reproductive and foraging energetics of pinnipeds: Implications for life history patterns. In: *Pinniped Behaviour*, D. Renouf ed., Chapman Hill.

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Projects: *Joint UCSB-MMS Pacific OCS Student Internship and Trainee Program*
Advancing Marine Biotechnology: Use of OCS Oil Platforms as Sustainable Sources of Marine Natural Products
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Education:	A.A.	Liberal Arts, De Anza Junior College, Cupertino, CA	1977
	B.A.	Aquatic Biology, University of California, Santa Barbara	1980
	Ph.D.	Biology, University of California, Santa Barbara	1990

Positions:	1995-present	Assistant Research Biologist, Marine Science Institute, University of California, Santa Barbara
	1990-95	Postdoctoral Researcher, Marine Science Institute, University of California, Santa Barbara
	1994	Postdoctoral Fellow, Department of Marine Science, University of Otago, New Zealand
	1993	Postdoctoral Fellow, Department of Zoology, University of Port Elizabeth, Republic of South Africa
	1988-93	Marine Biologist, Cooperative Park Science Unit, University of California, Davis, Channel Islands National Park, Ventura, CA

Selected Publications:

Dugan, J.E. and D. Hubbard. Southern New Zealand Beaches. In: Natural History of Southern New Zealand. Darby, J. and W. Harrex (eds.) University of Otago Press and the Otago Museum, Dunedin, New Zealand. (in press)

Dugan, J.E., Hubbard, D.M., McCrary, M., and M. Pierson. 2003. The response of macrofauna communities and shorebirds to macrophyte wrack subsidies on exposed sandy beaches of southern California. *Estuar. Coastl. Shelf Sci*. **56** (in press)

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Dugan, J.E. 1990. *Geographic and temporal variation in the life history, growth, and reproductive biology of the sand crab, Emerita analoga (Stimpson)*. Ph.D. Dissertation. University of California, Santa Barbara. 329p.

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Project: *Population Dynamics and Biology of the California Sea Otter at the Southern End of its Range*

Education:	B.A.	Zoology, University of Minnesota	1967
	M.S.	Zoology, Washington State University	1969
	Ph.D.	Biological Sciences/Statistics, University of Arizona	1974

Positions:	1984-present	Supervisory Zoologist, GM-486/15, California Science Center, National Biological Service, Santa Cruz, California
	1978-pressent	Adjunct Professor, Biological Sciences, University of California, Santa Cruz
	1979-present	Research Biologist, Institute for Marine Sciences, University of California, Santa Cruz
	1978-1981	Wildlife Biologist (Research), GS-486/12, Marine Mammal Section, National Fish and Wildlife Laboratory, FWS, Santa Cruz, California
	1977-1978	Wildlife Biologist (Research), GS-486/12, Marine Mammal Section, National Fish and Wildlife Laboratory, FWS, Anchorage, Alaska
	1974-1977	Wildlife Biologist (Research), GS-486/11, Marine Mammal Section, National Fish and Wildlife Laboratory, FWS, Anchorage, Alaska

Selected Publications:

Estes, J.A., Hatfield, B.B., Ralls, K., et al. 2003. Causes of mortality in California sea otters during periods of population growth and decline. *Mar. Mammal Sci.* **19**(1): 198-216.

Gelatt, T.S., Siniff, D.B., and J.A. Estes. 2002. Activity patterns and time budgets of the declining sea otter population at Amchitka Island, Alaska. *J. Wildlife Manage.* **66**(1): 29-39.

Schroeter, S.C., Reed, D.C., Kushner, D.J., et al. 2001. The use of marine reserves in evaluating the dive fishery for the warty sea cucumber (*Parastichopus parvimensis*) in California, USA. *Can. J. Fish. Aquat. Sci.* ***58***(9): 1773-1781.

Jackson, J.B.C., Kirby, M.X., Berger, W.H., et al. 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science* **293**(5530): 629-638.

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Paddack, M., and J.A. Estes. 2000. Comparison of kelp forest fish populations inside and outside of marine reserves in central California. *Ecological Applications* **10**(3): 855-870.

Estes, J.A. and C.H. Peterson. 2000. Marine ecological research in seashore and seafloor systems: accomplishments and future directions. *Marine Ecology Progress Series* **195**: 281-289.

Anthony, R.G., Miles, A.K., Estes, J.A., et al. 1999. Productivity, diets, and environmental contaminants in nesting bald eagles from the Aleutian Archipelago. *Environ. Toxic. Chem.* **18**(9): 2054-2062.

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Scott, J.M., Norse, E.A., Arita., H., Dobson, A., Estes, J.A., Foster, M., Gilbert, B., Jensen, D.B., Knight, R.L., Mattson, D. and M.E. Soulé. 1999. The issue of scale in selecting and designing biological reserves. Pp. 19-38 in, M. E. Soulé and J. Terborgh, eds., *Continental Conservation*, Island Press, Washington, D.C.

Terborgh, J., Estes, J.A., Paquet, P., Ralls, K., Boyd-Herger, D., Miller, B.J., and R.F. Noss. 1999. The role of top carnivores in regulating terrestrial ecosystems. Pp. 39-64 in, M. E. Soulé and J. Terborgh, eds., *Continental Conservation*, Island Press, Washington, D.C.

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Estes, J.A. 1999. Otter-eating orcas-Response to Garshelis and Johnson. *Science* **283**(5399): 177.

Golet, G.H., Irons, D.B., and J.A. Estes. 1998. Survival costs of chick rearing in black-legged kittiwakes. *J. Animal Ecology* **61**(5): 827-841.

Lindberg, D.L., Estes, J.A. and K.A. Warheit. 1998. Human influences on trophic cascades along rocky shores. *Ecological Applications* **8**(3): 880-890.

Estes, J.A., Tinker, M.T., Williams, T.M., and D.F. Doak. 1998. Killer whale predation on sea otters linking oceanic and nearshore ecosystems. *Science* **282**: 473-476.

Estes, J.A. 1998. Concerns about the rehabilitation of oiled wildlife. *Conservation Biology* **12**: 1156-1157.

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Estes, J.A., Bacon, C.E., Jarman, W.M., Nordstrom, R.J., Anthony, R.G., and A.K. Miles. 1997. Organochlorines in sea otters and bald eagles from the Aleutian Archipelago. *Marine Pollution Bulletin* **34**: 486-490.

Estes, J.A. 1996. Predators and ecosystem management. *Wildlife Soc. Bull.* **24**: 390-396.

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Ralls, K., DeMaster, D., and J.A. Estes 1996. Developing a criterion for delisting the southern sea otter under the US Endangered Species Act. *Conservation Biology* **10**(6): 1528-1537.

Stern, J.L., Hagerman, A.E., Steinberg, P.D., Winter, F.C., and J.A. Estes. 1996. A new assay for quantifying brown algal phlorotannins and comparisons to previous methods. *J. Chem. Ecol.* **22**: 1273-1293.

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Estes, J.A. 1996. The influence of large, mobile predators in aquatic food webs: examples from sea otters and kelp forests. Pp.65-72 in S.P.R. Greenstreet and M.L. Tasker, eds., *Aquatic Predators and their Prey*. Fishing News Books, Oxford.

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Project: *Ecological Consequences of Alternative Abandonment Strategies for POCS Offshore Facilities and Implications for Policy Development*

Education:	B.S.	Zoology, University College of Wales, Aberystwyth, U.K.	1985
	M.S.	Zoology, University of Sydney, Australia	1988
	Ph.D.	Zoology, University of New Hampshire	1992

Positions:	1999-Present	Assistant Professor, Department of Biological Sciences, University of Rhode Island
	1995-1999	Assistant Professor, Department of Organismic Biology, Ecology and Evolution, University of California, Los Angeles
	1993-95	Postdoctoral Research, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara
	1992	Statistical Consultant, Ithaca College
	1991	Research Associate, Arizona State University
	1985	Research Technician, University of Wales

Distinctions:	1998	Faculty Career Development Award, University of California, Los Angeles
	1997	Mildred Mathias award for top rated natural science proposal to UCMEXUS Program
	1991-92	Dissertation Fellowship, University of New Hampshire
	1989	Stoye Award
	1989-1990	Summer Graduate Fellowships, University of New Hampshire
	1986-88	University Postgraduate Research Scholarship, University of Sydney

Selected Publications:

Forrester, G.E and S.E. Swearer. Quantifying the use of different nursery habitats by juvenile California halibut through the analysis of trace-elements in otoliths. *Limnology and Oceanography* (in review).

O'Bryan, L.M. and G.E. Forrester. Horizontal distributions of *Chaoborus punctipennis*: documentation of patterns and tests of moonlight as a proximal controlling factor. *Hydrobiologia* (in review).

Steele, M.A. and G.E. Forrester. Early post-settlement predation on three reef fishes: effects on spatial patterns of abundance. *Ecology* (in review).

Steele, M.A., McClean, A.M., Malone, J.C., Forrester, G.E., and M.H. Carr. A test for limitation of population size by larval supply in the kelp bass (*Paralabrax clathratus)*. *Oecologia* (in review).

Swearer, S.E., Forrester, G.E., Steele, M.A., Brooks, A.J., and D.W. Lea. 2003. Spatio-temporal and interspecific variation in otolith trace-elemental fingerprints in a temperate estuarine fish assemblage. *Estuarine, Coastal and Shelf Science* (in press).

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Forrester, G.E., Vance, R.R., and M.A. Steele. 2002. Simulating Large-Scale Population Dynamics Using Small-Scale Data. Invited chapter in *Coral Reef Fishes: Dynamics and Diversity in a Complex Ecosystem*, P.F. Sale (editor), pp. 275-301. Academic Press.

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Holbrook, S.J., Forrester, G.E., and R.J. Schmitt. 2000. Spatial patterns in abundance of damselfish reflect availability of suitable habitat. *Oecologia* **122**(1): 109-120.

Forrester, G.E. 1999. The influence of adult density on the settlement of larval coral reef fish *(Coryphopterus glaucofraenum). Coral Reefs* **18**: 85-89.

Forrester, G.E., Dudley, T.L., and N.B. Grimm. 1999. Trophic interactions in open systems: influences of predators and nutrients on food chains in streams. *Limnology and Oceanography* **44**: 1187-1197.

Malone, J.M., Forrester, G.E., and M.A. Steele. 1999. Effects of subcutaneous microtags on the growth, survival and vulnerability to predation of small reef fishes. *Journal of Experimental Marine Biology and Ecology* **237**: 243-253.

Steele, M.A., Forrester, G.E., and G.R. Almany. 1998. Influences of predators and conspecifics on recruitment of a tropical and temperate reef fish. *Marine Ecology Progress Series* **172**: 115-125.

O'Bryan, L.M. and G.E. Forrester. 1997. Effects of fish presence and simulated moonlight gradients on night-time horizontal movements of a predatory zooplankter (*Chaoborus punctipennis*). *Journal of Plankton Research* **19**(10): 1441-1453.

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Forrester, G.E. 1991. Social rank, individual size and group composition as determinants of food consumption by humbug damselfishes *(Aruanus* spp.). *Animal Behaviour* **42**(5): 701-711.

Forrester G.E. 1990. Factors influencing the juvenile demography of a coral-reef fish. *Ecology* **71**(5): 1666-1681.

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Application of Coastal Ocean Dynamics Radars for Observation of Near-Surface Currents off the South-Central California Coast
Observing the Surface Circulation Along the South-Central California Coast Using High Frequency Radar: Consequences for Larval and Pollutant Dispersal
Advancing Marine Biotechnology: Use of OCS Oil Platforms as Sustainable Sources of Marine Natural Products

Education:

B.S.	Biology, University of California, Irvine	1977
Ph.D.	Ecology, Oregon State University	1982

Positions:

1997-present	Director, Marine Science Institute, University of California, Santa Barbara
1994-present	Associate Professor, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, CA
1993-1994	Associate Professor, Brown University, Providence, RI
1987-1993	Assistant Professor, Brown University, Providence, RI
1986-1987	Research Associate, Brown University, Providence, RI
1982-1986	Postdoctoral Fellow, Stanford University, Stanford, CA

Selected Publications:

Blanchette, C.A., Miner, B.G., and S.D. Gaines. 2002. Geographic variability in form, size and survival of Egregia menziesii around Point Conception, California. *Mar. Ecol. Prog. Ser.* **239**: 69-82.

Phillips, N.E. and S.D. Gaines. 2002. Spatial and temporal variability in size at settlement of intertidal mytilid mussels from around Pt. Conception, California. *Invertebr. Reprod. Dev.* **41**(1-3): 171-177.

Sagarin, R.D. and S.D. Gaines. 2002. Geographical abundance distributions of coastal invertebrates: using one-dimensional ranges to test biogeographic hypotheses. *J. Biogeogr.* **29**(8): 985-997.

Sagarin, R.D. and S.D. Gaines. 2002. The 'abundant centre' distribution: to what extent is it a biogeographical rule? *Ecol. Lett.* **5**(1): 137-147.

Sax, D.F., Gaines, S.D., and J.H. Brown. 2002. Species invasions exceed extinctions on islands worldwide: A comparative study of plants and birds. *American Naturalist* **160**(6): 766-783.

Botsford, L.W., Hastings, A., and S.D. Gaines. 2001. Dependence of sustainability on the configuration of marine reserves and larval dispersal distance. *Ecol. Lett.* **4**(2): 144-150.

Broitman, B.R., Navarrete, S.A., Smith, F., et al. 2001. Geographic variation of southeastern Pacific intertidal communities. *Marine Ecology Progress Series* **224**: 21-34.

Wares, J.P., Gaines, S.D., and C.W. Cunningham. 2001. A comparative study of asymmetric migration events across a marine biogeographic boundary. *Evolution* **55**(2): 295-306.

Gaylord, B. and S.D. Gaines. 2000. Temperature or transport? Range limits in marine species mediated solely by flow. *American Naturalist* **155**(6): 769-789.

Taylor, P.H. and S.D. Gaines. 1999. Can Rapoport's rule be rescued? Modeling causes of the latitudinal gradient in species richness. *Ecology* **80**(8): 2474-2482.

Bertness, M.D., Gaines, S.D., and S.M. Yeh. 1998. Making mountains out of barnacles: the dynamics of hummock formation. *Ecology* **79**: 1382-1394.

Hacker, S. and S.D. Gaines. 1997. Some implications of direct positive interactions for community species diversity. *Ecology* **78**: 1990-2003.

Worcester, S. and S.D. Gaines. 1997. Quantifying hermit crab recruitment rates and larval shell selection on wave swept shores. *Marine Ecology Progress Series* **157**: 307-310.

Bertness, M., Gaines, S.D., and R. Wahle. 1996. Wind-driven settlement patterns in the acorn barnacle, *Semibalanus balanoides*. *Marine Ecology Progress Series* **137**: 103-110.

Gaines, S.D. 1995. Modeling the dynamics of marine species: the importance of incorporating larval dispersal. Pp. 389-423 in: *Ecology of Marine Invertebrate Larvae*, Larry McEdward, ed. CRC Press.

Gaines, S.D. and M. Bertness. 1994. Does variable transport general variable settlement in coastal and estuarine species? Pp. 315-322 in: *Changes in Fluxes in Estuaries: Implications from Science to Management,* K. Dyer and R. Orth, eds. Olsen and Olsen, London.

Rice, W.R. and S.D. Gaines. 1994. Extending nondirectional heterogeneity tests to evaluate simply ordered alternative hypotheses. *Proceedings of the National Academy of Sciences* **91**: 225:226.

Rice, W.R. and S.D. Gaines. 1994. Heads I win, tails you lose: testing directional alternative hypotheses in ecological and evolutionary research. *Trends in Ecology and Evolution* **9**: 235-237.

Rice, W.R. and S.D. Gaines. 1994. The ordered-heterogeneity test. *Biometrics* **50:** 1-7.

Sanford, E., Bermudez, E., Bertness, M., and S.D. Gaines. 1994. Flow, food supply, and the population dynamics of acorn barnacles. *Marine Ecology Progress Series* **104**: 49-62.

Bertness, M. and S.D. Gaines. 1993. Larval dispersal and local adaptation in acorn barnacles. *Evolution* **47**: 316-320.

Gaines, S.D. and M. Bertness. 1993. The dynamics of juvenile dispersal: Why field ecologists must integrate. *Ecology* **74**: 2430-2435.

Gaines, S.D. and M. Denny. 1993. The largest, smallest, highest, lowest, longest, and shortest: Extremes in ecology. *Ecology* **74**: 1677-1692.

Rice, W.R. and S.D. Gaines. 1993. Calculating P-values for ANOVA with unequal variances. *Journal of Statistical Computation and Simulation* **46**: 19-22.

Bertness, M., Gaines, S.D., Stephens, E., and P. Yund. 1992. Components of recruitment in populations of the acorn barnacle *Semibalanus balanoides*. *Journal of Experimental Marine Biology and Ecology* **156**: 199-215.

Gaines, S.D. and M. Bertness. 1992. Dispersal of juveniles and variable recruitment in sessile marine species. *Nature* **360**: 579-580.

Bertness, M., Gaines, S.D, Bermudez, D., and E. Sanford. 1991. Extreme spatial variation in the growth and reproductive output of the acorn barnacle *Semibalanus balanoides*. *Marine Ecology Progress Series* **75**: 91-100.

Yund, P., Gaines, S.D., and M. Bertness. 1991. Cylindrical tube traps for sampling larvae. *Limnology and Oceanography* **36**: 1167-1177.

Denny, M. and S.D. Gaines. 1990. On the prediction of maximum intertidal wave forces. *Limnology and Oceanography* **35**: 1-15.

Gaines, S.D. and W.R. Rice. 1990. Analysis of biological data with ordered expectations. *American Naturalist* **135**: 310-317.

SCOTT A. HODGES
Department of Ecology, Evolution and Marine Biology
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Santa Barbara, CA

Projects: *Population Genetics of Surfgrass (Phyllospadix torreyi) for Use in Restoration*
Advancing Marine Biotechnology: Use of OCS Oil Platforms as Sustainable Sources of Marine Natural Products

Education:	B.A.	Botany & Biology, University of California, Berkeley, CA	1983
	Ph.D.	Botany, University of California, Berkeley, CA	1990

Positions:	2000-Present	Associate Professor, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, CA
	1995-2000	Assistant Professor, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, CA
	1993-1995	Postdoctoral Associate, Departments of Botany and Genetics, University of Georgia, Athens, GA
	1992	Research Associate, Department of Genetics, University of Georgia, Athens, GA
	1991	Visiting Assistant Professor of Biology, Bernard College, Columbia University, New York, NY

Education:	B.A.	Botany and Biology, University of California, Berkeley	1983
	Ph.D.	Botany, University of California, Berkeley	1990

Positions:	1995 - present	Assistant/Associate Professor, Dept. of Ecology, Evolution and Marine Biology, UCSB
	1993 - 1995	Postdoctoral Associate, Depts. of Botany and Genetics, Univ. of Georgia, Athens, GA
	1992	Research Associate, Dept. of Genetics, University of Georgia, Athens, GA
	1991	Visiting Assistant Professor of Biology, Barnard College, Columbia Univ. New York, NY
	1983-1990	Research Associate, Research Associate, Teaching Assistantship at UC Berkeley

Awards and Honors:

1998	UCSB nominee for Packard Fellowship
1997	Regents' Junior Faculty Fellowship
1996	Regents' Junior Faculty Fellowship
1994	Menzel Award, Genetics Section, Botanical Society of America
1988	Distinguished Instructor, University of California, Berkeley
1987-88	Regents Fellowship, University of California, Berkeley

Selected Publications:

Bush, D.S., Reed, D., Hollbrook, S., and S.A. Hodges. Sex-specific markers for surfgrass (*Phyllospadix torreyi*) reveal extreme female-biased sex ratios. *Molecular Ecology* (in prep).

Taylor, D.L., Bruns, T.D., Szaro, T.M., and S.A. Hodges. 2003. Divergence in mycorrhizal specialization within *Hexalectris spicata* (Orchidaceae), a non-photosynthetic desert orchid. *American Journal of Botany* (in press).

Whittall, J.B., Zimmer, E., Molina-Medino, A., and S.A. Hodges. 3'-UTR anchored amplification of nuclear genes: an efficient method for isolating numerous low copy nuclear introns. *Molecular Phylogenetics & Evolution* (in prep).

Yang, J. and S.A. Hodges. Microsatellite markers for evolutionary studies in *Aquilegia*. *Molecular Ecology* (in prep).

Hodges, S.A., Whittall, J.B., Fulton, M., and J.Y. Yang. 2002. Genetics of floral traits influencing reproductive isolation between *Aquilegia Formosa* and *A. pubescens*. *American Naturalist* **159**: S51-S60.

Bushakra, J.M., Hodges, S.A., Cooper, J.B., and D.D. Kaska. 1999. The extent of clonality and genetic diversity in the Santa Cruz Island Ironwood *Lyonothamnus floribundus*. *Molecular Ecology* **8**: 471-476 (cover photo).

Fulton, M. and S.A. Hodges. 1999. Floral isolation between *Aquilegia formosa* and *A. pubescens. Proceedings of the Royal Society of London, Series B* **266**: 2247-2252

Baker, H.G., Baker, I., and S.A. Hodges. 1998. Sugar composition of nectars and fruits consumed by birds and bats in the tropics and subtropics. *Biotropica* **30**: 559-586.

Hodges, SA. 1997. A rapid adaptive radiation via a key innovation in *Aquilegia*. Molecular evolution and adaptive radiations. pg. 391-405. Eds. T. Givinish and K. Sytsma. Cambridge University Press, Cambridge.

Hodges, SA. 1997. Floral nectar spurs and diversification. *International Journal of Plant Sciences* **158**: S81-S88.

Carney, S.E., Hodges, S.A., and M.L. Arnold. 1996. Effects of differential pollen-tube growth on hybridization in the Louisiana irises. *Evolution* **47**: 1432-1445.

Emms, S.K., Hodges, S.A., and M.L. Arnold. 1996. Pollen-tube competition, siring success and consistent asymmetric hybridization in the Louisiana irises. *Evolution* **50**: 2201-2206.

Hodges, S.A., Burke, J., and M.L. Arnold. 1996. Natural formation of iris hybrids: experimental evidence on the establishment of hybrid zones. *Evolution* **47**: 2504-2509

Arnold, M.L. and S.A. Hodges. 1995. Are natural hybrids fit or unfit relative to their parents? *Trends in Ecology and Evolution* **10**: 67-70.

Arnold, M.L. and S.A. Hodges. 1995. The fitness of Hybrids - A response to Day and Schluter. Trends in Ecology and *Evolution* **10**: 289.

Hodges, S.A. 1995. The influence of nectar production on hawkmoth behavior, self pollination and seed production in *Mirabilis multiflora* (Nyctaginaceae). *American Journal of Botany* **82**: 197-229.

Hodges, S.A. and M.L. Arnold. 1995. Spurring plant diversification: Are floral nectar spurs a key evolutionary innovation? *Proceedings of the Royal Society of London, Series B* **262**: 343-348.

Hodges, S.A. and M.L. Arnold 1994. Columbines: a geographically wide-spread species flock. *Proceedings of the National Academy of Sciences, USA* **91**: 5129-5132.

Hodges, S.A. and M.L. Arnold. 1994. Floral and ecological isolation between *Aquilegia formosa* and *A. pubescens*. *Proceedings of the National Academy of Sciences, USA* **91**: 2493-2496.

Hodges, S.A. 1993. Consistent interplant variation in nectar characteristics of *Mirabilis multiflora*. *Ecology* **74**: 542-548.

Hodges, S.A. 1987. Some preliminary observations on hawkmoth pollination of *Oenothera caespitosa* and *Mirabilis multiflora*. pages. 244-249 In: C. A. Hall and V. Doyle- Jones, eds., Plant Biology of Eastern California. Natural History of the White-Inyo Range Symposium, Vol. 2. University of California, White Mountain Research Station, Los Angeles, California.

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Projects: *An Experimental Evaluation of Methods of Surfgrass (Phyllospadix torreyi) Restoration Using Early Life History Stages*
Population Genetics of Surfgrass (Phyllospadix torreyi) for Use in Restoration

Education:	B.A.	Biology, Smith College	1970
	Ph.D.	Zoology, University of California, Berkeley	1975

Positions:	1987-present	Professor, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara
	1981-87	Associate Professor, Department of Biological Sciences, University of California, Santa Barbara
	1975-81	Assistant Professor, Department of Biological Sciences, University of California, Santa Barbara

Selected Publications:

Bull, J. S., Reed, D. C., and S. J. Holbrook. An experimental evaluation of different methods of restoring *Phyllospadix torreyi* (Surfgrass) (submitted).

Holbrook, S. J. and R. J. Schmitt. Population dynamics of a damselfish: effects of a competitor that also is an indirect mutualist (submitted).

Holbrook, S. J. and R. J. Schmitt. Ecological performance of a tropical anemone: benefits of hosting anemonefish (submitted).

Schmitt, R. J. and S. J. Holbrook. Mutualism can mediate competition and promote coexistence (submitted).

Bernardi, G., Holbrook, S.J., Schmitt, R.J. and Crane, N.L. Long-distance dispersal in an edge population of the coral reef three-spot damselfish *Dascyllus trimaculatus*. *Marine Biology* (in press).

Holbrook, S.J. and R. J. Schmitt. 2003. Spatial and temporal variation in mortality of newly settled damselfish: patterns, causes and co-variation with settlement. *Oecologia* **135**: 532-541.

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Bolker, B.M., St.Mary, C.M., Osenberg, C.W., Schmitt, R.J., and S.J. Holbrook. 2002. Management at a different scale: marine ornamentals and local processes. *Bulletin of Marine Science* **70**:733-748.

Brooks, A.J., Schmitt, R.J. and S.J. Holbrook. 2002. Declines in regional fish populations: have species responded similarly to environmental change? *Marine and Freshwater Research* **53**(2): 189-198.

Holbrook, S.J. and R.J. Schmitt. 2002. Competition for shelter space causes density-dependent mortality in damselfishes. *Ecology* **83**: 2855-2868.

Holbrook, S.J., Brooks, A., and R.J. Schmitt. 2002. Predictability of fish assemblages on coral patch reefs. *Marine and Freshwater Research* **53**(2): 181-188.

Holbrook S.J., Brooks, A.J., and R.J. Schmitt. 2002. Variation in structural attributes of patch-forming corals and in patterns of abundance of associated fishes. *Mar Freshwater Res* **53**(7): 1045-1053.

Holbrook, S.J., Reed, D.C., and J.S. Bull. 2002. Survival experiments with outplanted seedlings of surfgrass (Phyllospadix torreyi) to enhance establishment on artificial structures. *ICES J. Mar. Sci.* **59**: S350-S355 Suppl. S.

Osenberg, C.W., St.Mary, C.M., Schmitt, R.J., Holbrook, S.J., Chesson, P., and B. Byrne. 2002. Rethinking ecological inference: density-dependence in reef fishes. *Ecology Letters* **5**(6): 715-721.

Schmitt, R.J. and S.J. Holbrook. 2002. Correlates of spatial variation in settlement of two tropical damselfishes. *Marine and Freshwater Research* **53**(2): 329-337.

Schmitt, R.J. and S.J. Holbrook. 2002. Spatial variation in concurrent settlement of three damselfishes: relationships with near-field current flow. Oecologia **131**: 391-401.

Bernardi, G., Holbrook, S.J., and R.J. Schmitt. 2001. Gene flow in the coral reef three-spot dascyllus, *Dascyllus trimaculatus*, at three spatial scales. *Marine Biology* **138**: 457-465

Holbrook, S.J., Forrester, G.E., and R.J. Schmitt. 2000. Spatial patterns in abundance of a damselfish reflect availability of suitable habitat. *Oecologia* **122**(1): 109-120.

Holbrook, S.J., Reed, D.C., Hansen, K., et al. 2000. Spatial and temporal patterns of predation on seeds of the surfgrass *Phyllospadix torreyi*. *Mar. Biol.* **136**(4): 739-747.

Schmitt, R.J. and S.J. Holbrook. 2000. Habitat-limited recruitment of coral reef damselfish. *Ecology* **81**(12): 3479-3494.

Blanchette, C.A., Worcester, S., Reed, D., and S.J. Holbrook. 1999. Algal morphology, flow and spatially variable recruitment of surfgrass, *Phyllospadix torreyi*. *Marine Ecology Progress Series* **184**: 119-128.

Holbrook, S.J. and R.J. Schmitt. 1999. I*n situ* nocturnal observations of reef fishes using infrared video. In: Proc. 5th Indo-Pac. Fish Conf., Nouméa, 1997 (Séret B. & J.-Y. Sire, eds), pp. 805-812. Paris: Soc. Fr. Ichtyol.

Holbrook, S.J., Forrester, G.E., and R.J. Schmitt. 1999. Spatial patterns in abundance of a damselfish reflect availability of suitable habitat. *Oecologia*.

Schmitt, R.J. and S.J. Holbrook. 1999. Mortality of juvenile damselfish: implications for assessing processes that determine abundance. *Ecology* **80**: 35-50.

Schmitt, R.J. and S.J. Holbrook. 1999. Settlement and recruitment of three damselfish species: larval delivery and competition for shelter space. *Oecologia* **118**: 76-86.

Schmitt, R.J. and S.J. Holbrook. 1999. Temporal patterns of settlement of three species of damselfish of the genus *Dascyllus* (Pomacentridae) in the coral reefs of French Polynesia. In: Proc. 5th Indo-Pac. Fish Conf., Nouméa, 1997 (Séret B. & J.-Y. Sire, eds), pp. 537-551. Paris: Soc. Fr. Ichtyol.

Schmitt, R.J., Holbrook, S.J., and C.W. Osenberg. 1999. Quantifying the effects of multiple processes on local abundance: A cohort approach for open populations. *Ecology Letters* **2**: 294-303.

Holbrook, S.J. and R.J. Schmitt. 1998. Have field experiments aided in the understanding of abundance and dynamics of reef fishes? Pp. 152-169 in: *Issues and Perspectives in Experimental Ecology*, W.J. Resetarits and J. Bernado eds. Oxford University Press.

Reed, D.C., Holbrook, S.J., Solomon, E., and M. Anghera. 1998. Studies on germination and root development in the surfgrass *Phyllospadix torreyi*: Implications for habitat restoration. *Aquatic Botany* **62**: 71-80.

Holbrook, S.J. and R.J. Schmitt. 1997. Settlement patterns and process in a coral reef damselfish: *in situ* nocturnal observations using infrared video. *Proceedings of the VIIIth International Coral Reef symposium* **2:** 1143-1148.

ROBERT S. JACOBS
Department of Ecology, Evolution and Marine Biology
University of California
Santa Barbara, CA

Project: *Advancing Marine Biotechnology: Use of OCS Oil Platforms as Sustainable Sources of Marine Natural Products*

Education:	B.S.	Biology, Northwestern University, Evanston, IL	1964
	Ph.D.	Pharmacology, Stritch School of Medicine, Loyola University, Chicago, IL	1971

Positions:	1995-Present	Professor of Pharmacology, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, CA
	1982-1995	Professor of Pharmacology, Department of Biological Sciences, University of California, Santa Barbara, CA
	1978-1982	Associate Professor of Pharmacology, Department of Biological Sciences, University of California, Santa Barbara, CA
	1974-1978	Assistant Professor of Pharmacology, Department of Biological Sciences, University of California, Santa Barbara, CA
	1971-1974	Assistant Professor of Pharmacology, Department of Pharmacology, Stritch School of Medicine, Loyola University, Chicago, IL

Selected Publications:

Stevenson, C.S., Capper, E.A., Roshak, A.K., Marquez, B., Eichman, C., Jackson, J.R., Mattern, M., Gerwick, W.H., Jacobs, R.S., and L.A. Marshall. 2002. The identification and characterization of the marine natural product scytonemin as a novel antiproliferative pharmacophore. *J Pharmacol Exp Ther* **303**(2): 858-866.

Stevenson, C.S., Capper, E.A., Roshak, A.K., Marquez, B., Grace, K., Gerwick, W.H., Jacobs, R.S., and L.A. Marshall. 2002. Scytonemin - a marine natural product inhibitor of kinases key in hyperproliferative inflammatory diseases. *Inflamm Res* **51**(2): 112-114.

Bemis, D.L., Roussis, V., Vagias, C., and R.S. Jacobs. 2000. Chloroplast fatty acid composition in Mediterranean populations of the marine Chlorophyte, *Anadyomene stellata*. *Z Naturforsch C* **55**(7-8): 569-575.

MacPherson, J.C. and R.S. Jacobs. 2000. An 18.5 kDa protein from the amebocyte of Limulus polyphemus, homologous to the previously described amebocyte aggregation factor, expresses alternative phospholipase A(2) activity. *Comp Biochem Phys B* **127**(1): 31-44.

Mayer, A.M.S., Fenical, W., and R.S. Jacobs. 2000. The marine pseudopterosins modulate rat microglia superoxide and thromboxane generation. *FASEB J* **14**(8): 266.

Mayer, A.M.S., Oh, S., Fenical, W., and R.S. Jacobs. 1999. *Escherichia coli* LPS-primed rat brain microglia superoxide and thromboxane B-2 generation is inhibited by the marine pseudopterosins. *Shock* **11**: 58 Suppl. 1.

Pennings, S.C., Paul, V.J., Dunbar, D.C., Hamann, M.T., Lumbang, W.A., Novack, B., and R.S. Jacobs. 1999. Unpalatable compounds in the marine gastropod *Dolabella auricularia*: Distribution and effect of diet. *J Chem Ecol* **25**(4): 735-755.

Qureshi, A., Stevenson, C.S., Albert, C.L., Jacobs, R.S., and D.J. Faulkner. 1999. Homo- and nor-plakotenin, new carboxylic acids from the Palauan sponge *Plakortis lita*. *J Nat Prod* **62**(8): 1205-1207 Aug 1999.

MacPherson, J.C., Pavlovich, J.G., and R.S. Jacobs. 1998. Phospholipid composition of the granular amebocyte from the horseshoe crab, *Limulus polyphemus*. *Lipids* **33**(9): 931-940.

Mayer, A.M.S., Jacobson, P.B., Fenical, W., Jacobs, R.S., and K.B. Glaser. 1998. Pharmacological characterization of the pseudopterosins: Novel anti-inflammatory natural products isolated from the caribbean soft coral, *Pseudopterogorgia elisabethae. Life Sciences* **62**(26): 401-7.

Wylie, B.L., Ernst, N.B., Grace, K.J., and R.S. Jacobs. 1997. Marine natural products as phospholipase A_2 inhibitors. In: Progress in *Surgery*, Eds. W. Uhl, T.J. Nevalainen, and M.W. Büchler. Basel, Karger. **24**:146-152.

MacPherson, J.C., Pavlovich, J.G., and R.S. Jacobs. 1996. Biosynthesis of arachidonic acid metabolites in Limulus polyphemus amebocytes: Analysis by liquid chromatography-electrospray ionization mass spectrometry. *Biochim. Biophys. Acta.* **1303**(2): 127-36.

Michailova, M.V., Bemis, D.L., Wise, M.L., Gerwick, W.H., Norris, J.N., and R.S. Jacobs. 1995. Structure and synthesis of novel conjugated polene fatty acids from the marine green alga, *Anadyomene stellate*. *Lipids* **30**: 583-589.

Grace, K.J.S., Zavortink, D., and R.S. Jacobs. 1994. Inactivation of bee venom phospholipase A_2 by a sesquiterpene furanoic acid marine natural product. *Biochem. Pharm.* **47**: 1427-1434.

Marshall, L.A., Winkler, J.D., Griswold, D.E., Bolognese, B., Roshak, A., Sung, S.M., Webb, E.F., and R.S. Jacobs. 1994. Effects of scaradial, a type II phospholipase A_2 inhibitor on human neutrophil arachidonic acid mobilization and lipid media for formation. *J. Pharm. Exp. Ther.* **268**: 709-717.

Jacobs, R.S., Bober, M.A., Pinto, I., Williams, A.B., Jacobson, P.B., and M.S. de Carvalho. 1993. Pharmacological studies of marine novel marine metabolites. In: Advances of Marine Biotechnology, Vol. 1, Plenum, NY, p. 77-99.

Mayer, A.M.S., Paul, V.J., Fenical, W., Norris, J.N., de Carvalho, M.S., and R.S. Jacobs. 1993. Phospholipase A_2 inhibitors from marine algae. *Hydrobiologia* **260**(1):1-9.

Williams, A.B. and R.S. Jacobs. 1993. A marine natural product, Patellamide D, reverses multidrug resistance in a human leukemic cell line. *Cancer Letters* **71**: 97-102.

Potts, B.C.M., Faulkner, D.J., and R.S. Jacobs. 1992. Phospholipase A_2 inhibitors from marine organisms. *J. Natural Products* **55**: 1701-1717.

EDWARD A. KELLER
Department of Environmental Studies
& Department of Geological Sciences
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Santa Barbara, CA

Project: *Joint UCSB-MMS Pacific OCS Student Internship and Trainee Program*

Education:	B.S.	Mathematics, California State University, Fresno	1965
	B.A.	Geology, California State University, Fresno	1968
	M.S.	Geology, University of California	1969
	Ph.D.	Geology, Purdue University	1973

Positions:	1989-92;	
	1993-present	Chair of the Environmental Studies Program, University of California, Santa Barbara
	1976-present	Professor, Department of Geological Sciences, University of California, Santa Barbara
	1973-76	Asst. Professor, Department of Environmental Studies, University of North Carolina

Selected Publications:

Keller, E.A. 2002. Introduction to Environmental Geology, second edition, Prentice Hall, Upper Saddle River, New Jersey.

Keller, E.A., and N. Pinter. 2002. Active Tectonics, 2nd edition, Upper Saddle River. New Jersey, Prentice Hall.

Keller, E.A. 2001. Environmental Geology, 8th Edition, Upper Saddle River, New Jersey, Prentice Hall.

Keller, E.A., Johnson, D.L., Laduzinsky, D.L., Seaver, D.B., and T.L. Ku. 2000. Tectonic Geomorphology of Active Folding Over Buried Reverse Faults: San Emigdio Mountain Front, Southern San Joaquin Valley, California, *Geological Society of America Bulletin* **112**: 86-97.

Botkin, D.B. and E.A. Keller. 1999. Environmental Science, 3rd Edition, New York, John Wiley and Sons, Inc.

Keller, E.A., Gurrola, L., and T.E. Tierney. 1999. Geomorphic criteria to determine direction of lateral propagation of reverse faulting and folding. *Geology* **27**: 515-518.

Botkin, D.B. and E.A. Keller. 1998. *Environmental Science.* New York, John Wiley and Sons. 649 p.

Keller, E.A., Zepeda, R.L., Rockwell, T.K., Ku, T.L., *et al*. 1998. Active tectonics at Wheeler Ridge, Southern San Joaquin Valley, California. *Geological Society of America Bulletin* **110**: 298-310.

Pinter, N., Lueddecke, S.B., Keller, E.A., and K.R. Simmons. 1998. Late Quaternary slip on the Santa Cruz Island fault, California. *Geological Society of America Bulletin* **110**: 711-722.

Trecker, M.A., Gurrola, L.D., and E.A. Keller. 1998. Oxygen - isotope correlation of marine terraces and uplift of the Mesa hills, Santa Barbara, CA, USA. In: Stewart I.S. &Vita-Finzi, C.(eds) Coastal Tectonics. Geological Society, London, Special Publications 146:57-69 (invited contribution).

Keller, E.A., Valentine, D.W., and D.R. Gibbs. 1997. Hydrological response of small watersheds following the Southern California Painted Cave Fire of June 1990. *Hydrological Processes* **11**: 40-414.

Keller, E.A. and N. Pinter. 1996. *Active Tectonics.* Englewood Cliffs, New Jersey, Prentice Hall Inc. 338 p.

Keller, E.A. and H.A. Loaiciga. 1993. Fluid-pressure induced seismicity at regional scales. *Geophysical Research Letters* **20**(16): 1683-1686.

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Education:			
	B.S.	Physics/ Astronomy, SUNY at Stony Brook, New York	1984
	M.S.	Aeronomy, University of Michigan	1989
	Ph.D.	Atmospheric Sciences, Georgia Institute of Technology	1995

Positions:		
	2001-Present	Researcher I, Marine Science Institute and Chemical Engineering Department, University of California, Santa Barbara, CA.
	1999-2001	Post Doctoral Researcher, Chemical Engineering Department, University of California, Santa Barbara, CA.
	1998-1999	Visiting Scientist, TNO Physics and Electronics Laboratory, The Hague, The Netherlands.
	1996-1999	Post Doctoral Researcher, Martin Ryan Institute of Marine Science, National University of Ireland, Galway, Ireland.

Selected Publications:

Leifer, I., De Leeuw, G., and L. Cohen. 2003. Bubbles and bubble plumes from wind-steepened breaking waves during the LUMINY wind-wave experiement: Part 1. Bubble Plume Characterization. *(in prep).*

Leifer, I., De Leeuw, G., and L. Cohen. 2003. Bubbles and bubble plumes from wind-steepened breaking waves during the LUMINY wind-wave experiement: Part 2. Bubble Plume Characterization. *(in prep).*

Leifer, I., Washburn, L., Clark, J., and R. Chen. 2003. The signature of marine bubble induced upwelling: The hydrocarbon seep example. (*in prep*).

Clark, J.F., Leifer, I., Washburn, L., and B.P. Luyendyk. 2003. Compositional changes in natural gas bubble plumes: Observations from the Coal Oil Point Seep Field. *Geo. Mar Lett*. (*submitted*).

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Leifer, I.S. 1995. A validation study of bubble-mediated air-sea gas transfer modeling, Ph.D. Thesis, Georgia Institute of Technology, Atlanta, GA.

Leifer, I.S., Asher, W.E., and P.J. Farley. 1995. A validation study of bubble mediated air-sea gas transfer modeling, *The Third International Symposium on Air-Water Gas Transfer Heidelberg University*, Eds. B. Jähne and E.C. Monahan, Aeon Verlag, Hanau, Germany, 269-283.

Asher, W.E., Farley, P.J., Higgins, B.J., Karle, L.M., Leifer, I.S., and E.C. Monahan. 1994. The influence of bubble plumes on air-sea gas exchange, *EOS Nov. 1 Supplement* **75**(44): 369.

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Projects: *Ecological performance and trophic links: comparisons among platforms and natural reefs for selected fishes and their prey*
Relative importance of POCS oil platforms on the population dynamics of two reef fishes in the Eastern Santa Barbara Channel

Education:

B.S.	Conservation of Natural Resources, University of California, Berkeley	1986
M.S.	Marine Sciences, Moss Landing Marine Laboratories, San Jose State University	1992
Ph.D.	Marine Sciences, University of North Carolina at Chapel Hill	1996

Positions:

2002-Present	Assistant Professor, Donald Bren School of Environmental Science and Management, UCSB
2002	Santa Barbara Coastal Ecosystem Long Term Ecological Research, UCSB
2001-2002	Assistant Research Biologist II, UCSB
2001	Fishery Biologist, NOAA-National Marine Fisheries Service
1998-2000	Postdoctoral Research, NSF, Office of Polar Programs
1996-1997	Postdoctoral Research Associate, NRC, NOAA-National Marine Fisheries Service, Beaufort, NC
1992-1996	Research assistant, Institute of Marine Sciences, University of North Carolina at Chapel Hill, NC
1988-1992	Research assistant, Moss Landing Marine Laboratories, Moss Landing, CA

Grants and Awards:

2002-2004	US Minerals Management Service
1999-2000	National Geographic Society
1997-2000	National Science Foundation
1996-1997	National Marine Fisheries Service

Selected Publications:

Lenihan, H. S. and C. H. Peterson. Sustaining oyster reef habitat by switching from dredging and tonging to diver hand-harvesting. *Fishery Bulletin* (submitted).

Lenihan, H. S., Peterson, C. H., Kim, S. L., Conlan, K. E., Fairey, R., McDonald, C., Grabowski, J. H., and J. S. Oliver. How variation in marine benthic community composition allows discrimination of multiple stressors. *Marine Ecology Progress Series* (in revision).

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Conlan, K. E., Lenihan, H. S., Kvitek, R. G., and J. S. Oliver. 1998. Iceberg scour disturbance to benthic communities in the Canadian High Arctic. *Marine Ecology Progress Series* **160**: 1-16.

Lenihan, H. S. and C. H. Peterson. 1998. How habitat degradation through fishery disturbance enhances effects of hypoxia on oyster reefs. *Ecological Applications* **8**: 128-140.

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Projects: *Ecological Performance and Trophic Links: Comparisons Among Platforms and Natural Reefs for Selected Fishes and their Prey*

Education:

B.A.	Environmental Biology (Honors), University of California Santa Barbara	1970
M.A.	Zoology, UCSB	1974
Ph.D.	Zoology, UCSB	1978

Positions:

1985-present	Assistant and Associate Research Biologist, Marine Science Institute, UCSB
1993-present	Science writer and Science Editor of *Dolphin Log*, Cousteau Society
1978-1988	Project Director, VANTUNA Research Group, Occidental College, Los Angeles

Grants and Awards:

2002-2003	Packard Foundation
2002	Sea Grant
2001-2002	California Artificial Reef Enhancement Program and Biological Resources Division, U. S. Geological Survey
2000-2001	National Marine Fisheries Service

Selected Publications:

Love, M. S., Caselle, J. E., and L. Snook. 2000. Fish assemblages around seven oil platforms in the Santa Barbara Channel. Fish. Bull. 98: 96-117.

Love, M. S., Caselle, J. E., 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: 497-513.

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Love, M. and W. Westphal. 1990. A comparison of fishes taken by a sportfishing party vessel around oil platforms and adjacent natural reefs near Santa Barbara, California. Fish. Bull. 88:599-605.

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Education:	B.S.	Geology/ Geophysics, San Diego State College, California	1965
	Ph.D.	Oceanography/ Marine Geophysics, Scripps Inst. of Oceanography, San Diego, California.	1969

Positions:	1997-Present	Chair, Department of Geological Sciences, University of California, Santa Barbara
	1988-1997	Directory, Institute for Crustal Studies, University of California, Santa Barbara
	1987-1988	Acting Director for Institute of Crustal Studies, UC Santa Barbara
	1981-Present	Professor, Department of Geological Sciences, University of California, Santa Barbara
	1975-1981	Associate Professor, Department of Geological Sciences, UC Santa Barbara
	1973-1975	Assistant Professor, Department of Geological Sciences, UC Santa Barbara

Selected Publications:

Luyendyk, B.P., Smith, C.H., and G. Druivenga. Gravity measurements on King Edward VII Peninsula, Marie Byrd Land, West Antarctica, during GANOVEX VII, Geolog. Jahrb. (in press).

Siddoway, C.H. and B.P. Luyendyk. Crustal structure and Cenozoic tectonics on the eastern margin of the Ross Sea, Marie Byrd Land. Antarctic J. of the U.S. (in press).

Larson, R.L., Pockalny, R.A., Viso, R.F., Erba, E., Abrams, L.J., Luyendyk, B.P., Stock, J.M., and R.W. Clayton. 2002. Mid-Cretaceous tectonic evolution of the Tongareva triple junction in the southwestern Pacific basin. *Geology* **30**: 67-70.

Hamilton, Rhea, Luyendyk, B.P., Sorlien, C.C., and L.R. Bartek. 2001. Cenozoic Tectonics of the Cape Roberts Rift Basin, and Transantarctic Mountains Front, Southwestern Ross Sea, Antarctica. *Tectonics* **20**: 325-342.

Luyendyk, B.P. and E.T. Egland. 2001. Variation in discharge from marine hydrocarbon seeps at Coal Oil Point, CA: Implications for offshore oil production, Contribution #418-137 TC of the Institute for Crustal Studies, UCSB, 42 pp.

Luyendyk, B.P., Sorlien, C.C., Wilson, D., Bartek, L., and C.H. Siddoway. 2001. Structural and tectonic evolution of the Ross Sea rift in the Cape Colbeck region, Eastern Ross Sea, Antarctica. *Tectonics* **20**: 933-958.

Clark, J., Washburn, L., Hornafius, J.S., and B.P. Luyendyk. 2000. Natural Marine Hydrocarbon Seep Source of Dissolved Methane to California Coastal Waters. *J. Geophys. Res. - Oceans* **105**(11): 509-11,522.

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Hamilton, Rhea, Sorlien, C.C., Luyendyk, B.P., Bartek, L.R., and S. A. Henrys. 1998. Tectonic regimes and structural trends off Cape Roberts, Antarctica. *Terra Antartica* **5**: 261-272.

Henrys, S.A., Bartek, L.R., Brancolini, G., Luyendyk, B., Hamilton, R.J., Sorlien, C.C., and F.J. Davey. 1998. Seismic stratigraphy of the pre-quaternary strata off Cape Roberts and their correlation with strata cored in the CIROS-1 drill hole, McMurdo sound. *Terra Antartica* **5**: 273-279.

Luyendyk, B.P. 1998. Structure under the Santa Barbara Channel: The thick and thin of it, in, Kunitomi, D. S., Hopps, T. E., and Galloway, J. M., eds., Structure and Petroleum Geology, Santa Barbara Channel, California, Amer. Assoc. Petroleum Geol., Pacific Section, Misc. Pub. 46, 75-78.

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Schermer, E., Luyendyk, B.P., and S. Cisowski. 1996. Late Cenozoic structure and tectonics of the northern Mojave Desert. *Tectonics* **15**: 905-932.

Wateren, F.M. van der, Verbers, A.L.L.M., Luyendyk, B.P., Smith, C.H., Hofle, H. Chr., Vermeulen, F.J.M., de Wolf, H., Herpers, U., Klas, W., Kubik, P.W., Suter, W., and B. Dittrich-Hannen. 1996. Glaciation and deglaciation of the uplifted margins of the Cenozoic West Antarctic rift system, Ross Sea, Antarctica. *Geologisches Jahrbuch* **B89**, Polar issue no. 6, p. 123-155.

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Wateren, F.M. van der, Luyendyk, B.P., Verbers, A.L.L.M., and C.H. Smith. 1994. Landscape evolution model of the West Antarctic Rift system relating tectonic and climatic evolutions of the rift margins. *Terra Antarctica* **1**(2): 453-456.

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Project: *Ecological Consequences of Alternative Abandonment Strategies for POCS Offshore Facilities and Implications for Policy Development*

Education:	B.A.	Political Science, University of California, Los Angeles	1985
	M.A.	Political Science, University of California, Santa Barbara	1988
	Ph.D.	Political Science, University of California, Santa Barbara	1993

Positions:	2001-present	Adjunct Assistant Professor, Donald Bren School of Environmental Science & Management
	1998-00	Lecturer, UCSB Environmental Studies Program
	1996-present	Co-Director and Founder, The Center for Bioregional Conflict Resolution, Santa Cruz, California
	1995-present	Research Political Scientist, Ocean and Coastal Policy Center, Marine Science Institute, University of California, Santa Barbara
	1994	Lecturer, Department of Political Science, University of California, Santa Barbara
	1992-94	Visiting Assistant Professor, Department of Political Science, University of Oregon
	1992-94	Research Associate, Institute for Sustainable Environment, Department of Planning and Public Policy, University of Oregon
	1991	Technical Consultant, Santa Barbara County Energy Division
	1990	Lecturer, Department of Political Science, University of California, Santa Barbara

Selected Publications:

Woolley, J.T., McGinnis, M.V., and J. Kellner. 2002. The California watershed movement: Science and the politics of place. *Nat. Resour. J.* **42**(1): 133-183.

Woolley, J.T. and M.V. McGinnis. 2000. The conflicting discourses of restoration. *Soc. Natur. Resour.* **13**(4): 339-357.

McGinnis, M.V. 1999. *Bioregionalism: The Tug and Pull of Place*. London, New York: Routledge. 231 p.

McGinnis, M.V. 1999. Making the watershed connection. *Policy Stud. J.* **27**(3): 497-501.

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McGinnis, M.V. 1994. Collective bads: The case of low-level radioactive waste compacts. *Natural Resources Journal* **34**: 563-588.

McGinnis, M.V. 1994. Myth, nature and the bureaucratic experience. *Environmental Ethics* **16**: 425-434.

McGinnis, M.V. 1994. The politics of restocking vs. restoring salmon in the Columbia River Basin. *Restoration Ecology* **2**: 1-7.

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McGinnis, M.V. 1990. *The multiple uses of the ocean and coastal zone offshore California*. California Sea Grant Publication, Working Paper P-T-51. California Sea Grant College Program, CA.

J. CARTER OHLMANN
Institute for Computational Earth System Science
University of California
Santa Barbara, CA

Project: *Transport over the Inner-Shelf of the Santa Barbara Channel*

Education:	B.A.	Applied Mathematics, University of California, San Diego, CA	1986
	MA.	Architecture, California Polytechnic University, San Luis Opispo, CA	1991
	M.S.	Mechanical Engineering, University of Calfornia, Santa Barbara, CA	1995
	Ph.D.	Geography (Oceanography), University of California, Santa Barbara, CA	1997

Positions:	2000-Present	Assistant Research Oceanographer, Institute for Computational Earth System Science, University of California, Santa Barbara, CA
	1998-2000	Postdoctoral Researcher, Physical Oceanography Research Division, Scripps Institution of Oceanography, La Jolla, CA
	1997-1998	Post Postdoctoral Researcher, Institute for Computational Earth System Science, University of California, Santa Barbara, CA
	1992-1997	Research Assistant, Institute for Computational Earth System Science, University of California, Santa Barbara, CA

Selected Publications:

LaCasce, J. H. and J. C. Ohlmann. 2002. Relative dispersion at the surface of the Gulf of Mexico, *Journal of Marine Research* (in press).

Ohlmann, J. C., and A.L. Sybrandy. 2002. A catch-and-release Lagrangian drifter for near-shore ocean circulation research. *Proceedings, California and the World Ocean '02* (in press)

Ohlmann, J.C. and P.P. Niiler. 2001. A two-dimensional response to a tropical storm on the Gulf of Mexico shelf. *J Marine Syst* **29**(1-4): 87-99.

Ohlmann, J.C., Niiler, P.P., Fox, C.A., and R.R. Leben. 2001. Eddy energy and shelf interactions in the Gulf of Mexico. *J Geophys Res-Oceans* **106**(C2): 2605-2620.

Blaha, J. P., Born Jr., G. H., Guinasso, N. L., Herring, H. J., Jacobs, G. A., Kelly, F. J., Leben Jr., R. R., Martin, R. D., Mellor, G. L., Niiler, P. P., Parke, M. E., Patchen, R. C., Schaudt, K., Scheffner, N. W., Shum, C. K., Ohlmann, C., Sturges, W., Weatherly, G. L., Webb, D., and H. J. White. 2000. Gulf of Mexico ocean monitoring system. *Oceanography* **13**(2): 10-17.

Ohlmann, J.C., and D.A. Siegel. 2000. Ocean radiant heating: Part II. Parameterizing solar radiation transmission through the upper ocean. *J Phys Oceanogr* **30**(8): 1849-1865.

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Siegel, D.A., Westberry, T.K., and J.C. Ohlmann. 1999. Cloud color and ocean radiant heating. *J Climate* **12**(4): 1101-1116.

Ohlmann, J.C., Siegel, D.A., and L. Washburn. 1998. Radiant heating of the western equatorial Pacific during TOGA-COARE. *J Geophys Res-Oceans* **103**(C3): 5379-5395.

Ohlmann, J.C., Siegel, D.A., and C. Gautier. 1996. Ocean mixed layer radiant heating and solar penetration: A global analysis. *J Climate* **9**(10): 2265-2280.

Siegel, D.A., Ohlmann, J.C., Washburn, L., Bidigare, R.R., Nosse, C.T., Fields, E., and Y.M. Zhou. 1995. Solar-Radiation, Phytoplankton Pigments and the Radiant Heating of the Equatorial Pacific Warm Pool. *J Geophys Res-Oceans* **100**(C3): 4885-4891.

HENRY M. PAGE
Marine Science Institute
University of California
Santa Barbara, CA

Projects: *Habitat Value of Shell Mounds to Ecologically and Commercially Important Benthic Species*
Advancing Marine Biotechnology: Use of OCS Oil Platforms as Sustainable Sources of Marine Natural Products
Ecological Performance and Trophic Links: Comparisons Among Platforms and Natural Reefs for Selected Fishes and their Prey

Education:			
	B.S.	University of Southern California	1973
	M.A.	University of California, Santa Barbara	1977
	Ph.D.	University of California, Santa Barbara	1984

Positions:		
	1985-present.	Assistant Research Biologist, Marine Science Institute, University of California, Santa Barbara
	1984-1998.	Lecturer in Summer Session, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara
	1994-1997.	Instructor, Department of Biological Sciences, Santa Barbara City College
	1983-1985.	Postgraduate Research Biologist, Marine Science Institute, University of California, Santa Barbara

Selected Publications:

Bomkamp, R. E., Page, H. M., and J. E. Dugan. "Top down"-bottom up controls on benthic community structure: comparison of shell mounds at existing and former offshore oil platform sites. *Marine Ecology Progress Series* (submitted).

Galindo-Bect, M. S., Page, H. M., Petty, R. L., Hernandez-Ayon, M., Aragon-Noriega, E. A., and H. Bustos-Serrano. Temporal variation in the abundance of postlarval and juvenile blue shrimp (*Litopenaeus stylirostris*) and brown shrimp (*Farfantepenaeus californiensis*) in the Colorado River Estuary. *Fishery Bulletin* (submitted).

Page, H. M., S. Schroeter, D. Reed, R. F. Ambrose, J. Callaway, and J. Dixon. 2003. An inexpensive method to identify the elevation of tidally inundated habitat in coastal wetlands. *Bulletin of the Southern California Academy of Sciences* (in press).

Page, H. M. and M. Lastra. 2003. Diet of intertidal bivalves in the Ria de Arosa (Galicia, NW Spain): evidence from stable C and N isotope analysis. *Marine Biology* **143**.

Galindo-Bect, M.S., Glenn, E.P., Page, H.M., Galindo-Bect, L.A., Hernandez-Ayon, J.M., Petty, R.L., and J. Garcia-Hernandez. 2000. Analysis of peneid shrimp landings in the northern Gulf of California in relation to Colorado River discharge. *Fishery Bulletin - NOAA* **98**(1): 222-225.

Page, H.M., Dugan, J.E., Dugan, D., and J. Richards. 1999. Effects of an offshore oil platform on the distribution and abundance of commercially important crab species. *Marine Ecology Progress Series* **185**: 47-57.

Page, H.M. 1997. Importance of vascular plant and algal production to macroinvertebrate consumers in a southern California salt marsh. *Estuarine, Coastal and Shelf Science* **45**: 823-834.

Dugan, J.E., Hubbard, D.M., and H.M. Page. 1995. Scaling population density to body size: tests in two soft sediment intertidal communities. *Journal of Coastal Research* **11**: 849-857.

Page, H.M. 1995. Variation in the natural abundance of ^{15}N in the halophyte, *Salicornia virginica*, associated with ground water subsidies of nitrogen in a southern California salt marsh. *Oecologia* **104**: 181-188.

Page, H.M., Petty, R.L., and D.E. Meade. 1995. Influence of watershed run-off on nutrient dynamics in a southern California salt marsh. *Estuarine, Coastal and Shelf Science* **41**: 163-180.

Page, H.M., Dugan, J.E., and D.M. Hubbard. 1992. Comparative effects of infaunal bivalves on an epibenthic microalgal community. *Journal of Experimental Marine Biology and Ecology* **157**: 247-262.

Page, H.M., Fiala-Medioni, A., Fisher, C.R., and J.J. Childress. 1990. Experimental evidence for filter-feeding by the hydrothermal vent mussel, *Bathymodiolus thermophilus*. *Deep-Sea Research* **38**: 1455-1461.

Page, H.M., Fisher, C.R., and J.J. Childress. 1990. The role of filter-feeding in the nutritional biology of a deep sea mussel with methanotrophic symbionts. *Marine Biology* **104**: 251-257.

Page, H.M. and D.M. Hubbard. 1987. Temporal and spatial patterns of growth in mussels, *Mytilus edulis*, on an offshore platform: relationships to water temperature and food availability. *Journal of Experimental Marine Biology and Ecology* **111**: 159-179.

Page, H.M. 1986. Differences in population structure and growth rate of the stalked barnacle, *Pollicipes polymerus* between a rocky headland and an offshore oil platform. *Marine Ecology Progress Series* **29**: 157-164.

PETER T. RAIMONDI
Department of Biology- Ecology and Evolution
University of California
Santa Cruz, CA

Projects: *Effects of Produced Water on Complex Behavior Traits of Invertebrate Larvae and Algal Zoospores*
Effects of Temporal and Spatial Separation of Samples on Estimation of Impacts
Shoreline Inventory of Intertidal Resources of San Luis Obispo and Northern Santa Barbara Counties

Education:	B.A.	Philosophy, Northern Arizona University	1976
	Ph.D.	Biology, University of California, Santa Barbara	1988

Positions:	1996-present	Assistant Professor, Department of Biology, University of California, Santa Cruz
	1992-1996	Assistant Research Biologist, Marine Science Institute, University of California, Santa Barbara
	1991-1992	Post-doctoral Research Biologist, Marine Science Institute, University of California, Santa Barbara
	1989-1991	Research Fellow, Australian Research Council Fellowship, University of Melbourne, Department of Zoology
	1988-1989	Research Fellow, University of Melbourne Research Fellowship
	1987-1988	Post-doctoral Researcher, University of California, Santa Barbara
	1986-1990	Environmental Consultant, Marine Review Committee

Distinctions:	1976	President's Scholarship for Academic Excellence. Northern Arizona University
	1981-1982	Dean's Award for Academic Excellence, University of Arizona
	1984	Sigma Xi Grant-in-Aid of Research
	1986	University of California Patent Fund
	1987-1988	Office of Naval Research Postdoctoral Fellowship
	1988-1989	University of Melbourne Research Fellowship
	1989-1991	Australian Research Council Fellowship

Selected Publications:

Forde, S.E. and P.T. Raimondi. Recruitment intensity and intertidal community structure: comparing observations and experiments. *Oecologia* (in review)

Gaylord, B., Reed, D.C., Raimondi, P.T., Washburn, L., and S.R. McLean. 2002. A physically based model of macroalgal spore dispersal in the wave and current-dominated nearshore. *Ecology* **83**(5): 1239-1251.

Raimondi, P.T., Wilson, C.M., Ambrose, R.F., Engle, J.M., and T.E. Minchinton. 2002. Continued declines of black abalone along the coast of California: are mass mortalities related to El Nino events? *Marine Ecology Progress Series* **242**: 143-152.

Carr, M.H. and P.T. Raimondi. 2000. Concepts relevant to the design and evaluation of harvest reserves. Proceedings of workshop on rockfish refugia.

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Raimondi, P.T., Barnett, A.M., and P.R. Krause. 1997. The effects of drilling muds on marine invertebrate larvae and adults. *Environmental Toxicology and Chemistry* **16-6**: 1218-1228.

Altstatt, J.A., Ambrose, R.F., Engle, J.M., Haaker, P.L., Lafferty, K.D., and P.T. Raimondi. 1996. Recent declines of black abalone *Haliotis cracherodii* on the mainland coast of central California. *Marine Ecology Progress Series* **142**: 185-192.

Keough, M.J. and P.T. Raimondi. 1996. Responses of settling invertebrate larvae to bioorganic films: Effects of large-scale variation in films. *J. Exp. Mar. Biol. Ecology* **207**: 59-78.

Raimondi, P.T. and D. Reed. 1996. Determining the spatial extent of ecological impacts caused by local anthropogenic disturbances in coastal marine habitats. Pp. 179-198 in: *Detecting Ecological Impacts: Concepts and Applications in Coastal Habitat*s, R.J. Schmitt and C.W. Osenberg, eds. Academic Press, San Diego, CA.

Keough, M.J. and P.T. Raimondi. 1995. Responses of settling invertebrate larvae to microbial films, II: Effects of different types of films. *Marine Ecology Progress Series* **185**: 235-253.

Morse, D.E., Morse, A., Hooker, N., and P.T. Raimondi. 1994. Morphogen-based chemical flypaper for *Agaricia humilis* larvae. *Biological Bulletin* **186**: 172-181.

Lively, C.M., Raimondi, P.T., and L.F. Delph. 1993. Intertidal community structure: space-time interactions in the Northern Gulf of California. *Ecology* **74**: 162-173.

Keough, M.J. and P.T. Raimondi. 1992. Robustness of estimates of recruitment rates for sessile marine invertebrates. Recruitment Workshop Proceedings. *Australian Society of Fisheries Biologists*.

Raimondi, P.T. 1992. Adult plasticity and rapid larval evolution in a recently isolated barnacle population. *Biological Bulletin* **182**: 210-220.

Raimondi, P.T. and R.J. Schmitt. 1992. Effects of produced water on settlement of larvae: field tests using red abalone. Pp. 415-430 in: *Produced Water: Technological/Environmental Issues and Solutions.* J.P. Ray and F.R. Engelhardt, eds. Plenum Press, NY.

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Raimondi, P.T. and J.E. Martin. 1991. Evidence that mating group size affects allocation of reproductive resources in a simultaneous hermaphrodite. *American Naturalist* **138**: 1206-1217.

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Raimondi, P.T. and M.J. Keough. 1990. Behavioral variability in marine larvae. *Aust. J. Ecology* **15**: 427-437.

Raimondi, P.T. 1988. Rock type affects settlement, recruitment, and zonation of the barnacle *Chthamalus anisopoma* (Pilsbry). *Journal of Experimental Marine Biology and Ecology* **123**: 253-267.

Raimondi, P.T. 1988. Settlement cues and determination of the vertical limit of an intertidal barnacle. *Ecology* **69**: 400-407.

Lively, C.M. and P.T. Raimondi. 1987. Desiccation, predation, and mussel-barnacle interactions in the Northern Gulf of California. *Oecologia* **74**(2): 304-309.

KATHERINE RALLS
Department of Zoological Research
National Zoological Park
Smithsonian Institution
Washington, D.C.

Project: *Population Dynamics and Biology of the California Sea Otter at the Southern End of its Range*

Education:	B.A.	Biology, Stanford University	1960
	M.S.	Biology, Radcliffe College	1962
	Ph.D.	Biology, Harvard University	1965
Positions:	1998-Present	Senior Research Biologist, Smithsonian Institution, Washington, DC	
	1976-1998	Research Biologist, Smithsonian Institution, Washington, DC	

Selected Publications:

Haight, R.G., Cypher, B., Kelly, P.A., Phillips, S., Possingham, H.P., Ralls, K., Starfield, A.M., White, P.J., and D. Williams. 2002. Optimizing habitat protection using demographic models of population viability. *Conserv Biol* **16**(5): 1386-1397.

Ralls, K., Pilgrim, K.L., White, P.J., Paxinos, E.E., Schwartz, M.K., and R.C. Fleischer. 2001. Kinship social relationships, and den sharing in kit foxes. *J Mammal* **82**(3): 858-866.

Smith, D.A., Ralls, K., Davenport, B., Adams, B., and J.E. Maldonado. 2001. Canine assistants for conservationists. *Science* **291**(5503): 435-435.

Haight, R.G., Ralls, K., and A.M. Starfield. 2000. Designing species translocation strategies when population growth and future funding are uncertain. *Conserv Biol* **14**(5): 1298-1307.

Ralls, K. and B.L. Taylor. 2000. Better policy and management decisions through explicit analysis of uncertainty: New approaches from marine conservation - Introduction. *Conserv Biol* **14**(5): 1240-1242.

Ralls, K., Ballou, J.D., Rideout, B.A., and R. Frankham. 2000. Genetic management of chondrodystrophy in California condors. *Anim Conserv* **3**: 145-153 Part 2.

White, P.J., Ralls, K., and D.B. Siniff. 2000. Nocturnal encounters between kit foxes. *J Mammal* **81**(2): 456-461.

Frankham, R. and K. Ralls. 1998. Conservation biology - Inbreeding leads to extinction. *Nature* **392**(6675): 441-442.

Good, S.V., Williams, D.F., Ralls, K., and R.C. Fleischer. 1997. Population structure of *Dipodomys ingens* (Heteromyidae): The role of spatial heterogeneity in maintaining genetic diversity. *Evolution* **51**(4): 1296-1310.

Paxinos, E., McIntosh, C., Ralls, K., and R. Fleischer. 1997. A noninvasive method for distinguishing among canid species: Amplification and enzyme restriction of DNA from dung. *Mol Ecol* **6**(5): 483-486.

Ralls, K. and L.L. Eberhardt. 1997. Assessment of abundance of San Joaquin kit foxes by spotlight surveys. *J Mammal* **78**(1): 65-73.

Brody, A.J., Ralls, K., and D.B. Siniff. 1996. Potential impact of oil spills on California sea otters: Implications of the Exxon Valdez spill in Alaska. *Mar Mammal Sci* **12**(1): 38-53.

Ralls, K., Demaster, D.P., and J.A. Estes. 1996. Developing a criterion for delisting the southern sea otter under the US endangered species act. *Conserv Biol* **10**(6): 1528-1537.

Ralls, K., Eagle, T.C., and D.B. Siniff. 1996. Movement and spatial use patterns of California sea otters. *Can J Zool* **74**(10): 1841-1849.

DANIEL C. REED
Marine Science Institute
University of California
Santa Barbara, CA

Projects: *An Experimental Evaluation of Methods of Surfgrass (Phyllospadix torreyi) Restoration Using Early Life History Stages*
Population Genetics of surfgrass (Phyllospadix torreyi) for use in restoration

Education:	B.A.	Moss Landing Marine Laboratories and San Francisco State University	1978
	M.A.	Moss Landing Marine Laboratories and San Francisco State University	1981
	Ph.D.	University of California, Santa Barbara	1989

Positions:	1999-present	Research Biologist, Marine Science Institute, University of California, Santa Barbara
	1994-99	Associate Research Biologist, Marine Science Institute, UCSB
	1989-94	Assistant Research Biologist, Marine Science Institute, UCSB
	1990	Biological Consultant, Woodward-Clyde Consultants
	1987-90	Biological Consultant, Marine Review Committee
	1988-89	Biological Consultant, Michael Brandman Associates
	1986-87	Biological Consultant, Chambers Consultants

Distinctions:	1989	Lancaster Award for Outstanding Dissertation, University of California, Santa Barbara
	1984	Antarctic Service Medal of the United States of America, National Science Foundation

Selected Publications:

Bull, J. S., Reed, D. C., and S. J. Holbrook. An experimental evaluation of different methods of restoring *Phyllospadix torreyi* (Surfgrass) (submitted).

Page, H. M., Schroeter, S., Reed, D.C., Ambrose, R. F., Callaway, J., and J. Dixon. Variation in the distribution and abundance of salt marsh vegetation associated with elevation and height of tidal inundation. *Bulletin of the Southern California Academy of Sciences* (in press).

Gaylord, B., Reed, D.C., Raimondi, P.T., Washburn, L., and S.R. McLean. 2002. A physically based model of macroalgal spore dispersal in the wave and current-dominated nearshore. *Ecology* **83**(5): 1239-1251.

Holbrook, S.J., Reed, D.C., and J.S. Bull. 2002. Survival experiments with outplanted seedlings of surfgrass (Phyllospadix torreyi) to enhance establishment on artificial structures. *Ices J Mar Sci* **59**: S350-S355 Suppl. S.

Schroeter, S.C., Reed, D.C., Kushner, D.J., Estes, J.A., and D.S. Ono. 2001. The use of marine reserves in evaluating the dive fishery for the warty sea cucumber (Parastichopus parvimensis) in California, USA. *Can J Fish Aquat Sci* **58**(9): 1773-1781.

Holbrook, S.J., Reed, D.C., Hansen, K., and C.A. Blanchette. 2000. Spatial and temporal patterns of predation on seeds of surfgrass, *Phyllospadix torreyi*. *Mar Biol* **136**(4): 739-747.

Reed, D.C., Raimondi, P.T., Carr, M.H., and L. Goldwasser. 2000. The role of dispersal and disturbance in determining spatial heterogeneity in sedentary kelp-forest organisms. *Ecology* **81**(7): 2011-2026.

Blanchette, C.A., Worcester, S., Reed, D., and S.J. Holbrook. 1999. Algal morphology, flow and spatially variable recruitment of surfgrass, *Phyllospadix torreyi*. *Marine Ecology Progress Series* **184**: 119-128.

Reed, D.C., Brzezinski, M.A., Coury, D.A., Graham, W.M., and R.L. Petty. 1999. Neutral lipids in macroalgal spores and their role in swimming. *Marine Biology* **133**: 737-744

Reed, D.C., Holbrook, S.J., Solomon, E., and M. Anghera. 1998. Studies on germination and root development in the surfgrass *Phyllospadix torreyi*: Implications for habitat restoration. *Aquatic Botany* **62**: 71-80.

Reed, D.C., Anderson, T.W., Ebeling, A.W., and M. Anghera. 1997. Role of reproductive synchrony in the colonization potential of kelp. *Ecology* **78**: 2443-2457.

Canestro, D., Raimondi, P.T., Reed, D.C., Schmitt, R.J., and S.J. Holbrook. 1996. A study of methods and techniques for detecting ecological impacts. Pp. 53-67 in*: Methods and techniques of underwater research*, *Proceedings of the American Academy of Underwater Scientists symposium*. AAUS, Nahant, MA.

Raimondi, P.T. and D. Reed. 1996. Determining the spatial extent of ecological impacts caused by local anthropogenic disturbances in coastal marine habitats. Pp. 179-198 in: *Detecting Ecological Impacts: Conceptual Issues and Applications in Coastal Marine Habitat,* R.J. Schmitt and C.W. Osenberg, eds. Academic Press, San Diego, CA.

Reed, D.C., Ebeling, A.W., Anderson, T.W., and M. Anghera. 1996. Differential reproductive responses to fluctuating resources in two seaweeds with different reproductive strategies. *Ecology* **77**: 300-316.

Ambrose, R.F., Boland, J., Murdoch, W.W., Raimondi, P.T., and D.C. Reed. 1995. The San Onofre nuclear generating station mitigation reef: monitoring issues. Pp. 587-592 in: *Proceedings from the International Conference on Ecological System Enhancement Technology for Aquatic Environments*. Japan International Marine Science and Technology Federation, Tokyo.

Reed, D.C. 1994. Giant forests of the sea. *The World and I* **July**: 202-207.

Reed, D.C. and R.J. Lewis. 1994. Effects of an oil and gas production effluent on the colonization potential of giant kelp (*Macrocystis pyrifera*) zoospores. *Marine Biology* **119**: 277-283.

Reed, D.C., Lewis, R.J., and M. Anghera. 1994. Effects of an open coast oil production outfall on patterns of giant kelp (*Macrocystis pyrifera*) recruitment. *Marine Biology* **120**: 26-31.

Brzezinski, M, Reed, D.C., and C.D. Amsler. 1993. Neutral lipids as major storage products in *Macrocystis pyrifera*. *J. Phycology* **29**: 16-23.

Carr, M.H. and D.C. Reed. 1993. Conceptual issues relevant to marine harvest refuges: examples from temperate marine fishes. *Can. J. Fish. Aquat. Sci.* **50**: 2019-2028.

Amsler, C.D., Reed, D.C., and M. Neushul. 1992. The microclimate inhabited by algal propagules. *British Phycological Journal* **27**: 253-270.

Carr, M.H. and D.C. Reed. 1992. Harvest refuges and their potential for enhancing reef fisheries in southern California. Pp. 63-68 in: *Perspectives on the Marine Environment,* P.M. Grifman and S.E. Yoder, Eds. Sea Grant Program, University of California, Los Angeles.

Neushel, M., Amsler, C.D., Reed, D.C., and R.J. Lewis. 1992. The introduction of marine plants for aquacultural purposes. Pp. 103-138 in: *Movement and dispersal of biotic agents into aquatic ecosystems*, A. Rosenfield, ed. Maryland Sea Grant College, College Park, MD.

Reed, D.C., Amsler, C.D., and A.W. Ebeling. 1992. Dispersal in kelps: factors affecting spore swimming and competency. *Ecology* **73**: 1577-1585.

Reed, D.C., Neushul, M., and A.W. Ebeling. 1991. The role of density on gametophyte growth and reproduction in the kelps *Macrocystis pyrifera* and *Pterygophora californica*. *J. Phycol*. **27**: 361-366.

DANIEL SCHLENK
Professor, Aquatic Ecotoxicology
Department of Environmental Sciences
University of California
Riverside, CA

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

Education:

B.S.	Toxicology, Northeast Louisiana University	1984
Ph.D.	Toxicology, Oregon State University	1989

Positions:

2000-Present	Professor, Aquatic Ecotoxicology, Department of Environmental Sciences, University of California, Riverside, CA.
1999-2000	Program Coordinator of Environmental Toxicology Program, Environmental and Community Health Research Program, University of Mississippi, University, MS
1998-2000	Coordinator for the Graduate Program in Pharmacology, University of Mississippi
1995-1998	Assistant Professor of Pharmacology and Toxicology, University of Mississippi
1991-1995	Assistant Professor of Toxicology, University of Arkansas for Medical Sciences, Little Rock, AR
1989-1991	Postdoctoral Fellow, Duke University Marine Laboratory, Integrated Toxicology Program, Beaufort, NC

Selected Publications:

Roy, L. A., Armstrong, J. L., Sakamoto, K., Steinert, S., Perkins, E., Lomax, D. P., Johnson, L. L., and D. Schlenk. 2003. The relationships of biochemical endpoints to histopathology, and population metrics in feral flatfish species collected near the municipal outfall of Orange County, CA. *Environmental Toxicology and Chemistry* (in press).

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Tilton, F., Benson, W.H., and D. Schlenk. 2002. Evaluation of Estrogenic Activity from a Municipal Wastewater Treatment Plant with Predominantly Domestic Input. *Aquatic Toxicology* (in press).

Todorov, J.R., Elskus, A.A., Schlenk, D., Ferguson, P.L., Brownawell, B.J., and A.E. McElroy. 2002. Estrogenic Responses of Larval Sunshine Bass (Morone saxatilis X M. chrysops) Exposed to New York City Sewage Effluent. *Marine Environmental Research* (in press).

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Elalfy, A., Grisle, S., and D. Schlenk. 2001. Characterization of Salinity-enhanced toxicity of aldicarb to Japanese medaka: sexual and developmental differences. *Environmental Toxicology and Chemistry* **20**: 2093-2098.

Schlenk, D., Huggett, D.B, Block, D.S., Grisle, S., Allgood, J.,Bennet, E., Holder, A.W., Hovinga, R.M., and P. Bedient. 2001. Toxicity of Fipronil and its Degradation Products to Procambarus sp.: Field and Laboratory Studies. *Archives of Environmental Contamination and Toxicology* **41**: 325-332.

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Debusk, B.C., Kumir, S., Rimoldi, J., and D. Schlenk. 2000. Phase I and II enzyme and activity levels in the gumboot chiton Cryptochiton stelleri following exposure to a dietary bromo-phenol, lanosol. *Comparative Biochemistry and Physiology* **127C**: 133-142.

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Department of Ecology, Evolution and Marine Biology and
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Projects: *Population Trends and Trophic Dynamics in Pacific OCS Ecosystems: What Can Monitoring Data Tell us?*
Advancing Marine Biotechnology: Use of OCS Oil Platforms as Sustainable Sources of Marine Natural Products

Education:

B.A.	Environmental Biology, University of Colorado	1972
M.S.	Marine Science, University of the Pacific	1975
Ph.D.	Biology, University of California, Los Angeles	1979

Positions:

1995-present	Professor, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara
1994-present	Program Director, Coastal Marine Institute, University of California, Santa Barbara
1991-present	Program Director, Coastal Toxicology Program, UC Toxic Substances Research and Teaching Program
1989-present	Program Director, Southern California Educational Initiative, University of California, Santa Barbara
1987-present	Director, Coastal Research Center, Marine Science Institute, University of California, Santa Barbara
1993-1995	Associate Professor, Department of Biology and Environmental Studies Program, University of California, Santa Barbara
1987-1992	Associate Research Biologist, Marine Science Institute, University of California, Santa Barbara
1981-1987	Assistant Research Biologist, Marine Science Institute, University of California, Santa Barbara

Distinctions: 1989 George Mercer Award for 1989, Ecological Society of America (best published research in field of Ecology by a scientist under age 40; Awarded for "Indirect interactions between prey: apparent competition, predator aggregation and habitat selection," *Ecology* **68**:1887-1897)

Selected Publications:

Bernardi, G., Holbrook, S.J., Schmitt, R.J., Crane, N.L., and E. DeMartini. 2002. Species boundaries, populations and colour morphs in the coral reef three-spot damselfish (Dascyllus trimaculatus) species complex. *P Roy Soc Lond B Bio* **269**(1491): 599-605.

Bolker, B.M., St Mary, C.M., Osenberg, C.W., Schmitt, R.J., and S.J. Holbrook. 2002. Management at a different scale: Marine ornamentals and local processes. *B Mar Sci* **70**(2): 733-748.

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Buko, A.M., Beckner, C., Hepp, D., Helias, N., Zhu, F., Nemcek, T., Schmitt, R.J., and J. Hochlowski. 2001. Stability testing of chemical diversity in liquid DMSO storage. *Abstr Pap Am Chem S* **222**: 210-ANYL Part 1.

Schmitt, R.J. and S.J. Holbrook. 2001. Habitat-limited recruitment of coral reef damselfish. *Ecology* **81**(12): 3479-3494.

Holbrook, S.J., Forrester, G.E., and R.J. Schmitt. 2000. Spatial patterns in abundance of a damselfish reflect availability of suitable habitat. *Oecologia* **122**(1): 109-120.

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Ambrose, R.F., Schmitt, R.J., and C.W. Osenberg. 1996. Predicted and observed environmental impacts: can we foretell ecological change? Pp. 345-369 in: *Detecting Ecological Impacts: Concepts and Applications in Coastal Habitats*, R.J. Schmitt and C.W. Osenberg, eds. Academic Press, San Diego, CA.

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Project: *Population Dynamics and Biology of the California Sea Otter at the Southern End of its Range*

Education:	B.S.	Fisheries and Wildlife, Michigan State University	1957
	M.S.	Mathematical Statistics, Michigan State University	1958
	Ph.D.	Entomology, Fisheries & Wildlife, University of Minnesota	1967

Positions: 1975-Present Professor, Department of Ecology, Evolution and Behavior, University of Minnesota, St. Paul, MN
Director of the Itasca Biology Program, University of Minnesota, St. Paul, MN
Director of the Conservation Biology Graduate Program, University of Minnesota, St. Paul, MN

Selected Publications:

Gelatt, T.S., Siniff, D.B., and J.A. Estes. 2002. Activity patterns and time budgets of the declining sea otter population at Amchitka Island, Alaska. *J Wildlife Manage* **66**(1): 29-39.

Sato, K., Mitani, Y., Cameron, M.F., Siniff, D.B., Watanabe, Y., and Y. Naito. 2002. Deep foraging dives in relation to the energy depletion of Weddell seal (Leptonychotes weddellii) mothers during lactation. *Polar Biol* **25**(9): 696-702.

Gelatt, T.S., Davis, C.S., Siniff, D.B., and C. Strobeck. 2001. Molecular evidence for twinning in Weddell seals (*Leptonychotes weddellii*). *J Mammal* **82**(2): 491-499.

White, P.J., Ralls, K., and D.B. Siniff. 2000. Nocturnal encounters between kit foxes. *J Mammal* **81**(2): 456-461.

Monson, D.H., Estes, J.A., Bodkin, J.L., and D.B. Siniff. 2000. Life history plasticity and population regulation in sea otters. *OIKOS* **90**(3): 457-468.

Watt, J., Siniff, D.B., and J.A. Estes. 2000. Inter-decadal patterns of population and dietary change in sea otters at Amchitka Island, Alaska. *Oecologia* **124**(2): 289-298.

Gelatt, T.S., Arendt, T., Murphy, M.S., and D.B. Siniff. 1999. Baseline levels of selected minerals and fat-soluble vitamins in weddell seals (Leptonychotes weddellii) from Erebus Bay, McMurdo Sound, Antarctica. *Mar Pollut Bull* **38**(12): 1251-1258.

Bowen, D. and D. Siniff. 1999. Distribution, population biology, and feeding ecology of marine mammals. *In* Biology of Marine Mammals. J.E. Reynolds and S.A. Rommel, eds. *Smithsonian Press*. pp. 423-484.

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Brody, A.J., Ralls, K., and D. Siniff. 1996. Potential impact of oil spills on California sea otters: Implications of the Exxon Valdez spill in Alaska. *Marine Mammal Science* **12**(1): 38-53.

Ralls, K., Hatfield, B., and D. Siniff. 1995. Foraging patterns of California sea otters as indicated by telemetry. *Canadian Journal of Zoology* **73**: 523-531.

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Santa Barbara, CA

Project: *Public Perceptions of Risk Associated with Offshore Oil Development*

Education:	A.B.	University of California, Berkeley	1975
	M.A.	University of California, Berkeley	1976
	Ph.D.	University of California, Berkeley	1982

Positions:	1996-97	Director, University of California, Santa Barbara – Washington Center
	1990-present	Associate Professor, Department of Political Science, University of California, Santa Barbara
	1986-90	Assistant Professor, Department of Political Science, University of California, Santa Barbara
	1982-86	Assistant Professor, Department of Political Science, Columbia University
	1982	Lecturer in Politics, Brandeis University

Selected Publications:

Smith, Eric R.A.N. 2003. The Role of Knowledge in the Public's Trust in Science about Offshore Oil and Gas Development. MMS OCS Study 2002-0051. Coastal Research Center, Marine Science Institute, University of California, Santa Barbara, California. MMS Cooperative Agreement Number 14-35-0001-30761. 69 pages.

Smith, E.R.A.N. 2002. *Energy, the Environment, and Public Opinion*. Boulder, CO: Roman & Littlefield.

Smith, E.R.A.N. and R.L. Fox. 2001. The Electoral Fortunes of Women Candidates for Congress. *Political Research Quarterly* **54**: 205-21.

Smith, E.R.A.N., Squire, P., Lindsay, J.M., and C.R. Covington. 2001. *Dynamics of Democracy*, 3rd edition. St. Paul, MN: Atomic Dog.

Smith, E.R.A.N. 2000. Democratic Values vs. Environmentalism? In: *The Culture Wars by Other Means* Richard Ellis and Fred Thompson. University of British Columbia, Centre for Business and Government.

Smith, E.R.A.N. and M. Marquez. 2000. The Other Side of the NIMBY Syndrome. *Society & Natural Resources* **13**: 273-80.

Fox, R.L. and E.R.A.N. Smith. 1998. The role of candidate sex in voter decision-making. *Political Psychology* **19**: 405-419.

Smith, E.R.A.N. 1998. How Political Activists See Offshore Oil Development: An In-depth Investigation of Attitudes on Energy Development. MMS OCS Study 98-0042. Coastal Research Center, Marine Science Institute, University of California, Santa Barbara, California. MMS Cooperative Agreement Number 14-35-0001-30761. 195 pages.

Smith, ERAN. 1997. Book Review: What Americans know about politics and why it matters, by M.X.D. Carpini, S. Keeter. *Political Science Quarterly* **112**: 314-315.

Smith, E.R.A.N. 1996. Book Review: Public opinion in America - moods, cycles and swings, by J.A. Stimson. *Critical Review* **10**: 95-105.

Smith, E.R.A.N. 1996. Book Review: The changing American mind - how and why American public opinion changed between 1960 and 1988, by W.G. Mayer. *Critical Review* **10**: 95-105.

Smith, E.R.A.N. 1996. Book Review: The rational public - fifty years of trends in American policy preferences, by B. Page and R. Shapiro. *Critical Review* **10**: 95-105.

Smith, E.R.A.N. 1996. Book Review: The two majorities - the issue context of modern American politics, by B.E. Shafer and W.J.M. Claggett. *American Political Science Review* **90**: 438-439.

Squire, P. and E.R.A.N. Smith. 1996. A further examination of challenger quality in Senate elections. *Legislative Studies Quarterly*. **421**: 235-248.

Herrera, R., Epperlein, T., and E.R.A.N. Smith. 1995. The stability of congressional roll-call indexes. *Political Research Quarterly* **48**: 403-416.

Smith, E.R.A.N. and S.R. Garcia. 1995. Evolving California opinion on offshore oil development. *Ocean and Coastal Management* **26**: 41-56.

Squire, P., Smith, E.R.A.N., Lindsay, J. and C. Covington. 1995. *Dynamics of Democracy*. Brown-Bennchmark, Madison, Wisconsin. 596p.

Smith, E.R.A.N. 1992. Changes in the Public's political sophistication. In: *Controversies in Voting Behavior, 3rd edition*, R.G. Niemi and H.F. Weisberg, eds. Congressional Quarterly Press, Washington, D.C. (reprinted from *The Unchanging American Voter*).

Smith, E.R.A.N., Herrera, R., and C.L. Herrera. 1992. Public opinion and congressional representation. *Public Opinion Quarterly* **56**: 185-205.

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Smith, E.R.A.N. and P. Squire. 1984. Repeat challengers in congressional elections. *American Politics Quarterly* **12**: 51-70.

Tannenbaue, P., L. Kostrich, E.R.A.N. Smith and M. Berg. 1983. *Turned-on television and turned off voters: Policy options for election projections*. Sage Publications, Beverly Hills, CA.

DAVID L. VALENTINE
Department of Geological Sciences
University of California
Santa Barbara, CA

Project: *Weathering of Aromatic Compounds in the Coastal Marine Environment: Quantifying Rates of Microbial Metabolism*

Education:	B.S.	Chemistry/Biochemistry, Revelle College, U.C. San Diego	1995
	M.S.	Chemistry, University of California, San Diego	1996
	M.S.	Earth System Science, University of California, Irvine	1998
	Ph.D.	Earth System Science, University of California, Irvine	2000

Positions: 2001-Present Assistant Professor, Department of Geological Sciences, University of California, Santa Barbara, California.

Selected Publications:

Adams, C. and Valentine, D.L. Bioenergetics of secondary fermentations involving glycolate, butyrate, and alanine. (*in preparation)*

Chong, S., Liu, Y., Cummins, M., Valentine, D. L., Reysenbach, A. L., and D. R. Boone, *Methanogenium marinum* sp. nov., a H_2-Using Methanogen from Skan Bay, Alaska, and Kinetics of H_2 Utilization (*submitted* to Antonie von Leewanhoek).

Valentine, D. L., Chidthaisong, A., Rice, A., Reeburgh, W. S. and S. C. Tyler Carbon and hydrogen isotope fractionation by moderately thermophilic methanogens. (*submitted* to *Geochimica et Cosmochimica Acta)*

Valentine, D. L. 2002. Biogeochemistry and microbial ecology of anaerobic methane oxidation: a review. *Antonie von Leewanhoek.* (*in press)*

Chidthaisong, A., Chin, K-J., Valentine, D. L., and S. C. Tyler. 2002. A comparison of isotope fractionation of carbon and hydrogen from paddy field rice roots and soil bacterial enrichments during CO_2/H_2 methanogenesis. *Geochimica et Cosmochimica Acta* **66**: 983-995.

Valentine, D. L., Blanton, D. C., Reeburgh, W. S., and M. Kastner. 2001. Water column methane oxidation adjacent to an area of active hydrate dissociation, Eel River Basin. *Geochimica et Cosmochimica Acta* **65**:2633-2640.

Valentine, D. L. 2001. Thermodynamic ecology of hydrogen based syntrophy, *in* Symbiosis: Mechanisms and Model Systems, J. Seckbach ed., Kluwer Academic Publishers, Dordrecht.

Valentine, D. L., Blanton, D. C., and W. S. Reeburgh. 2000. Hydrogen production by methanogens under low hydrogen concentrations. *Archives of Microbiology* **174**:415-421.

Valentine, D. L., and W. S. Reeburgh. 2000. New perspectives on anaerobic methane oxidation. *Environmental Microbiology* **2**:477-484.

Valentine, D. L., and D. R. Boone. 2000. Diversity of methanogens, in Enigmatic Microorganisms and Life in Extreme Environments, Vol II, Diversity of Microorganisms, J. Seckbach ed., Kluwer Academic Publishers, Dordrecht p. 289-302.

Valentine, D. L. 2000. Biogeochemistry of Hydrogen and Methane in Anoxic Environments: Thermodynamic and Isotopic Studies. Ph.D. Dissertation in Earth System Science, University of California, Irvine, 173pp.

Valentine, D. L., Reeburgh, W. S., and D. C. Blanton. 2000. A culture apparatus for maintaining H_2 at sub-nanomolar concentrations. *Journal of Microbiological Methods* **39**, 243-251.

LIBE WASHBURN
Department of Geography &
Institute for Computational Earth Systems Science (ICESS)
University of California
Santa Barbara, CA

Projects: *Observing the Surface Circulation Along the South-Central California Coast Using High Frequency Radar: Consequences for Larval and Pollutant Dispersal*
Application of Coastal Ocean Dynamics Radars for Observation of Near-Surface Currents off the South-Central California Coast

Education:

B.S.	Mechanical Engineering, University of Arizona	1974
M.S.	Engineering Science, University of California, San Diego	1978
Ph.D.	Engineering Science, University of California, San Diego	1982

Positions:

1993-Present	Associate Professor, Department of Geography and ICESS, University of California, Santa Barbara, CA
1991-1993	Assistant Professor, Department of Geography, University of California, Santa Barbara, CA
1985-1990	Research Assistant Professor of Physical Oceanography, Center for Earth Sciences, University of Southern California, Los Angeles, CA
1982-1985	Postgraduate Research Oceanographer, Scripps Institution of Oceanography, San Diego, CA

Selected Publications:

Beckenbach, E.H., and L. Washburn. 2003. Observations of wavelike phenomena in the Santa Barbara Channel using high frequency radar. *Journal of Geophysical Research* (in press).

Emery, B.M., L. Washburn, and J. Harlan. 2002. Evaluating CODAR high frequency radars for measuring surface currents: observations in the Santa Barbara Channel. *Journal of Atmospheric and Oceanic Technology* (in press).

Beckenbach, E.H., and L. Washburn. 2002. Observations of Wavelike Phenomena in the Santa Barbara Channel Using HF Radar. *Eos Transactions, American Geophysical Union Ocean Sciences Meeting Supplement, Abstract OS32D-160*.

Gaylord, B., Reed, D.C., Raimondi, P.T., Washburn, L., and S.R. McLean. 2002. A physically based model of macroalgal spore dispersal in the wave and current-dominated nearshore. *Ecology* **83**(5): 1239-1251.

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Pinkel, R., Merrifield, M., McPhaden, M., Picault, J., Rutledge, S., Siegel, D., and L. Washburn. 1997. Solitary waves in the western Equatorial Pacific Ocean. *Geogphy. Res. Let*. **24**: 1603-1606.

Washburn, L. and B.H. Jones. 1996. Field Observations and Modeling of Dispersion Processes around Ocean Outfalls, Oceans 96 MTS/IEEE, Conf. Proc., (published on CD-ROM) 23-26 September, Fort Lauderdale, FL.

Washburn, L., Duda, T., and D. Jacobs. 1996. Interpreting conductivity microstructure: estimation of the temperature variance dissipation rate in the presence of salinity gradients. *J. Atmospheric and Oceanic Tech*. **13**: 1166-1188.

Siegel, D.A., Ohlmann, J.C., Washburn, L., Bidigare, R.R., Nosse, C.T., and Y. Zhou. 1995. Solar radiation, phytoplankton pigments and the radiant heating of the equatorial Pacific Warm Pool. *J. Geophys. Res*. **100**: 4885-4891.

Wu, Y., Washburn, L., and B.H. Jones. 1994. Buoyant plume dispersion in a coastal environment: observations of plume structure and dynamics. *J Cont Shelf Res* **14**: 1001-1023.

Jones, B.H., Dickey, T.D, Washburn, L., and D. Manow. 1993. Physical and biological dynamics of sewage outfall plumes in the coastal region: an integrated observational approach. Pp. 527-234 in: Water Pollution II: Modeling, measuring and prediction, L.C. Wrobel and C. A. Brebbia eds. Computational Mechanics Publications, Southampton.

Washburn, L., Swenson, M., Largier, J.L., Kosro, P.M., and S.R. Ramp. 1993. Cross-shelf sediment transport by an anti-cyclonic eddy off Northern California. *Science* **261**: 1560-1564.

Washburn, L., Jones, B.H., Bratkovich, A., Dickey, T.D., and M.S. Chen. 1992. Mixing, dispersion, and resuspension in the vicinity of an ocean wastewater plume. *J. Hydraulic Engr*. **118**: 38-58.

Huyer, A., Kosro, P.M., Fleischbein, J., Ramp, S.R., Stanton, T., Washburn, L., Chavez, F.P., Cowles, T.J., Pierce, S.D., and R.L. Smith. 1991. Currents and waste masses of the Coastal Transition Zone off Northern California, June to August 1988. *J. Geophys. Res*. **96**: 14809-14831.

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Project: *Population Dynamics and Biology of the California Sea Otter at the Southern End of its Range*

Education:	B.A.	Biology, Douglass College	1976
	M.S.	Physiology, Rutgers University	1979
	Ph.D.	Environmental & Exercise Physiology, Rutgers University	1981
		Certificate Program in Molecular Biotechnology, UC San Diego	1989

Position: 1997-present Associate Professor of Biology, University of California, Santa Cruz

Selected Publications:

Fuiman, L.A., Davis, R.W., and T.M. Williams. 2002. Behavior of midwater fishes under the Antarctic ice: observations by a predator. *Mar. Biol.* **140**(4): 815-822.

Kanatous, S.B., Davis, R.W., Watson, R., *et al*. 2002. Aerobic capacities in the skeletal muscles of Weddell seals: key to longer dive durations? *J. Exp. Biol.* **205**(23): 3601-3608.

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Pabst, D.A., McLellan, W.A., and T.M. Williams. 1999. Locomotor functions of dolphin blubber. *Am. Zool.* **39**(5): 680 Sp. Iss. SI.

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Project: *Advancing Marine Biotechnology: Use of OCS Oil Platforms as Sustainable Sources of Marine Natural Products*

Education:

B.S.	Pharmacy, Massachusetts College of Pharmacy & Allied Health Sciences, Boston, MA	1963
Ph.D.	Pharmacology, School of Medicine, Tufts University, Boston, MA	1967

Positions:

1995-present	Professor of Biochemistry and Pharmacology, Department of Molecular, Cellular, and Developmental Biology, University of California, Santa Barbara, CA
1978-1995	Professor of Biochemistry and Pharmacology, Division of Molecular, Cellular, and Developmental Biology, Department of Biological Sciences, University of Santa Barbara, CA
1987-1991	Chair, Department of Biological Sciences, University of California, Santa Barbara, CA
1976-1978	Associate Professor, Department of Biological Sciences, University of California, Santa Barbara, CA
1969-1975	Assistant Professor, Department of Pharmacology, Stanford University School of Medicine, Stanford, CA

Selected Publications:

Jordan, M.A., Ojima, I., Rosas, F., Distefano, M., Wilson, L., Scambia, G., and C. Ferlini. 2002. Effects of novel taxanes SB-T-1213 and IDN5109 on tubulin polymerization and mitosis *Chem Biol* **9**(1): 93-101.

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