
University of California

Southern California Educational Initiative

Annual Report

July 1999

University of California

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July 1999

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and
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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 SOUTHERN CALIFORNIA EDUCATIONAL INITIATIVE

**A University Research Initiative Program
involving the**

**University of California,
the State of California**

and the

**Minerals Management Service
US Department of Interior**

ANNUAL REPORT

PROGRAM YEAR 10

July 15, 1999

PROGRAM MANAGER'S REPORT xx

The Southern California Educational Initiative (SCEI) was initiated in May 1989 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. The university-based research program has just completed its tenth year, the fifth year of our renewed 6-year contract. This Annual Report summarizes activities and research progress during Program Year 10 (July 1, 1998 - June 30, 1999).

Major programmatic progress achieved during Program Year 10 of the SCEI is summarized below.

- ◆ The selection process (release of RFP, solicitation of full proposals, peer-review of full proposals, final selection) for new studies to begin in Program Year 10 was initiated, full proposals will be solicited this summer;
- ◆ A research retreat, co-sponsored by the SCEI and the complimentary state-funded training program (the UC Coastal Toxicology Program) was held in September 1998 at the Bodega Marine Laboratory to discuss and integrate findings by SCEI natural and social scientists and the UC Coastal Toxicology Program;
- ◆ In April 1999, the SCEI, in cooperation with the UC Coastal Toxicology Program, hosted the Annual Symposium of the UC Toxic Substances Research and Teaching

Program at Santa Barbara, California, at which studies sponsored by the SCEI were presented;

- ◆ This year, SCEI-sponsored studies produced 6 peer-reviewed papers that were published with an additional 12 manuscripts that are in press.
- ◆ Two Project Final Reports were completed and distributed.

SUMMARY OF RESEARCH PROGRESS

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Environmental Assessment: Statistical Description of Variable Effects on Fluctuating Populations

Adding Biology to BACI: Exploring the Use of Functional Groups, Trophic Relationships and Multiple, Ecologically Similar Comparison Sites in Choosing Models and Estimating Effects Impacts Analysis.

Principal Investigators Allan Stewart-Oaten, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, CA 93106, **Stephen Schroeter**,

Summary of Research, July 1998 - June 1999

Introduction and Summary

I apologize for going over the standard report length, but this is the last annual report on this project. It continues through the summer, with another report at the end, and we expect to continue working on it after the project ends. However, publishable progress has come more slowly than we hoped, so it seems appropriate to give more detail than usual.

The two main aims of these programs have been:

(1) to produce methods for estimating or describing effects of a long-lasting "alteration" of the environment on naturally fluctuating biological variables, which use one or more neighboring, similar "control" sites to reduce extraneous temporal variation and serial correlation in the data;

(2) to test these methods on real data, from the annual surveys of the Channel Islands National Park Service: specifically, to see whether neighboring, similar sites can be used to predict each other's fluctuations over time, such that the temporal variation and serial correlation of the residuals from the prediction are smaller than those of the original data.

A brief summary of the results so far is:

(1) At least two general methods are available, both of which can be regarded as special cases (or extensions) of a now-standard method called "intervention analysis." One uses the difference between values observed at the "Impact" site and those observed at the controls. The values at the sites might be transformed, and multiple values from a set of controls can be averaged or otherwise summarized. The other method uses control values as covariates; in effect, it finds equations for predicting Impact values from control values under "before alteration" conditions and compares their predictions with either the predictions of the corresponding equations under "after" conditions or with the actual values of the sites observed after the alteration is in place.

These methods are very similar: the use of subtraction is almost equivalent to using a simple linear regression equation with slope equal to 1 as the prediction equation in the covariate approach. They have two differences. First, when variables are transformed, results of the subtraction method are not easy to express in terms of untransformed variables. In particular, the natural question "what would the impact site value have been if there had been no alteration?" is not easy to answer, especially if a measure of uncertainty (like a confidence interval) is wanted. Second, the subtraction method seems the more likely to achieve its goals (reduced temporal variation and correlation) when sampling error is high.

(2) The Channel Islands data indicate that abundances of a species at different sites may not track each other usefully. For each of about 70 species, many of the 120 site pairs are poorly correlated. There is some tendency for sites which are close together (and on the same side of the chain of islands, i.e., either both facing toward the mainland or both facing away) to have higher correlations than other pairs, but this is not very strong.

One possible reason for these results is sampling variation. In one sense this is often high: e.g., the coefficient of variation = (SD among transects)/average is often well over 100%. However, it does not usually obscure real temporal variation: on average it accounts for only 1/6 - 1/12 of the variation in averages over time; it is more than half of it in about 15% of cases, and more than a third in about 33% of cases. Thus sampling variation should not usually obscure between site relationships.

A related problem is the frequency of zeros: years in which the species was not observed at all at either or both sites. Correlations can be dominated by a small number of non-zero years, being artificially high or low depending on whether these match or not. Matching may suggest some "tracking" due to region-wide blooms, but the effective sample size is small, and effects on a species usually seen only once or twice a decade would usually be of little interest.

A more complex and interesting problem is that the sites used are not "similar" but were deliberately chosen to "reflect the broad range of conditions and biological assemblages in the (Channel Islands National) Park" (G. Davis et al., "Kelp Forest Monitoring Handbook" Vol 1, p. 3). They vary in current patterns, depth, substrate, relief, aspect and exposure. Some of these may be as important as distance in determining which regional effects are realized locally.

Thus these results do not imply that control sites can't be useful (no other way to deal with temporal variation and autocorrelation in abundances has yet been proposed), but they show that details may matter. Different combinations of sites might be appropriate for different species (e.g., based on recruitment and preferences concerning depth, wave force, etc.). A different scale may be needed: e.g., we could split each site into two halves and see if these track each other, or we could group neighboring sites together and see if groups tend to track each other. We may need to allow for substrate: about 70% of all the substrate is rock, the rest being cobble or sand, but it may be that some species are found only on one of these substrates, so their zeros on other substrates should be ignored when computing average abundances. We will look further into transformation choice (so far, all seem to give similar results). A question we cannot answer with these data is whether the sites track each other over seasons: e.g., it could be useful to separate change due to recruitment (before vs after a limited recruitment season) from change due to mortality (between the end of one recruitment period and the beginning of the next).

Some details

(1) Work on methods: mainly clarification.

The methods we have proposed for estimating effects are not new. They can be seen as special cases of "intervention analysis," developed mainly by G. E. P. Box and G. C. Tiao in the 1960's and 70's. Their application to impact assessment goes back at least to my 1984 technical report for the San Onofre study, though I did not realize at the time how closely it was related to Box and Tiao's work. The use of "Control" sites goes back still further, but the idea that these sites should "control" (reduce) variation over time rather than over space was

usually missing. Misunderstanding of the potential benefits of these methods, and the assumptions they need, is still common, and even includes some statisticians (as I saw at the Biometric Society meeting in June 1999). Continued efforts to explain what the methods do and do not attempt are needed.

The specific problem is to describe how the "abundance" at the "Impact" site following an "alteration" differs from the abundance that would have arisen had there been no alteration, using sample counts taken Before and After the alteration. This is a time series problem: the task is to compare the Before time series to the After series, essentially by describing how they would differ if each could be continued for a long time (e.g., for the life of the alteration). This formulation makes it clear that variation between sites is not relevant. The Before-After comparison would make sense even if no non-Impact site existed. Indeed, this is the case in many problems, such as global warming, where the Earth itself is the "Impact" site.

In the local abundance problem, the time series available are often too short to account adequately for temporal variation, especially as this is often accompanied by serial correlation (i.e., abundances close in time tend to be close in value). The main way to deal with such difficulties is the use of covariates to explain and thus remove some of the variation and correlation. Environmental variables like temperature or nutrient levels are obvious candidates, but they are likely to require complicated nonlinear models involving synergistic effects and time delays. The data are usually too sparse for fitting such models. "Control" sites which are nearby, similar, but unaffected by the alteration, seem better candidates because they are likely to be responding to the same natural environmental changes with the same time delays.

There are two closely related standard ways to use such covariates. One is to fit the Impact site values to a (usually linear) function of the Control values. The "effect" of the alteration can then be estimated by comparing the Before and After fits, or by comparing actual observed After Impact values by what they would have been without the alteration, as estimated by the fit based on the Before data. The second is to compare the Before and After series of Impact-Control differences, and estimate the effect by the change.

The difference method is close to what the covariate method would be if the slope of the linear regression of Impact on Control were assumed to be 1. It is simpler, and our data suggest it may be more effective in reducing extraneous variance, but it is also less flexible. In particular, if the raw abundances are transformed (e.g., to logs) before applying the difference method, then only crude approximations are available for estimating the effect in terms of the original raw abundances. The method is also hard to apply if it is suspected that the effect of the alteration varies with conditions, e.g., as measured by the Control site abundances (e.g., if the alteration reduces abundances at times when they are normally high, but increases them at other times). The covariate method handles these problems of transformation and interpretation much better, but our data suggest that large sampling error can lead to poor control of temporal variation.

One mistaken objection to the method is that the error in estimating the effect must account for variation among sites. This confuses the covariate-controls with unreplicated experimental controls. This is seen to be wrong by considering the problem where no Controls are available, or only one is, or where the covariates include things like temperature, which are not measured in the same units as Impact site abundance - "variation" among these covariates makes no sense. Variation among sites would be important if an aim was to

generalize conclusions to other sites, as in an experiment, but assessment conclusions apply only to the site actually altered.

Another objection is that the methods assume the same "trajectories" at different sites. We need here to distinguish between the "realized" trajectory - the one that actually arises, resulting from deterministic and random (regional, local and sampling error) variation - and various "mean" trajectories resulting from averaging over one or more of the random sources. The methods assume that there is a functional relationship between the deterministic parts at different sites, and between some of the regional random variation at different sites. This will not make the realized trajectories the same, but could cause the error in predicting one by the other to be a time series with mean 0 and smaller temporal variation and serial correlation than the original site series, and enable temporal variation in the "without alteration" and "with alteration" series to be estimated from the Before and After data respectively. The likely violations of these assumptions are (i) that we choose the wrong functional relationship, (ii) that another source of variation arises at about the same time as the alteration (e.g., if there is dumping at one of the sites) and (iii) that much of the variation at a site is local in origin, so is not matched by variation at other sites. Item (i) is common in statistical studies, and assessed by sensitivity analyses. Item (ii) can be assessed by policing for human interference and by comparing the suites of effects with the mechanisms likely to result from the alteration. Item (iii) is the ongoing focus of this project.

Other minor objections include "sites must be observed simultaneously" (this is not needed for useful "tracking"), "differences must be independent" (this would simplify analyses but is no more essential than in other time series problems), "only effects on means can be estimated" (true if "means" includes conditional means, e.g., for different seasons and other conditions, but few time series methods attempt more, for good reasons), and "causes cannot be assessed" (this is true of all observational studies: no method could make assessment an exception).

(2) Work on data: mainly exploration.

The main problems with these methods are simple to state. When do they work - i.e., when do there exist suitable "control" sites that can effectively reduce temporal variation and serial correlation? For a particular species at a particular Impact site, what principles should guide the selection of control sites? What specific models are appropriate?

These are mainly empirical questions. Ideal data sets for studying them would be sampled abundances collected over many years, several times per year, at sets of neighboring sites that were similar in various ways. We have not been able to find such ideal data: when neighboring sites are sampled, the time period has usually been too short to be useful.

The best data set we know is from the Channel Islands National Park Service. These are annual surveys of about 70 species at 13 sites since 1981; a further site was added in 1983 and two more in 1986. There are data on size and recruitment, but we have worked mainly with the abundance data for three groups, "band", "quad" and "rpc." These names refer to the sampling method. At each site, all samples use a single 100-metre transect. The positions on this transect are chosen anew each year, by choosing a random point near the start and spacing positions equally from it to the end. The number of positions varies between groups and has varied within groups from year to year. The "band" species are sampled by counting in bands (currently 3X20m but this has varied) across the transect at the chosen positions. The "quad" species are sampled by counts in quadrats (currently 2m² but this has varied), and

the "rpc" species by the fractions of contacts with (currently) 40 points on the boundaries of two randomly placed concentric ellipses.

After some reorganization of the data to allow for variation in sampling methods over years, our main efforts have gone into programming to allow interactive plotting and summarization of correlation calculations. In particular, we can compute correlations for all species between all pairs of sites, or for selections of either species or site-pairs, using either the yearly averages of the raw abundances at each site, or power transformations (e.g., square roots, logs, reciprocals) of them. We can then select promising cases for plotting or model fitting.

These efforts are incomplete but the results so far have been less than we hoped. We have found some cases where the Impact-Control differences are less variable than either site is alone, and a smaller number where the covariate method reduces extraneous variation. However, this required selection from a large number of cases - about 70 species X 120 site-pairs, although not all these combinations gave correlation values (e.g., some species were never seen at some sites).

A general summary of the raw values and their correlations is given in the tables below. These seem to us to confirm the main messages above: sampling variation is quite high but not enough to obscure relationships over years; correlations are not as high as might be expected from "similar" neighbors all driven by the same regional events; but some neighbors are consistently highly correlated, either overall for some groups of species, so further study, seeking more biological linkages between sites is needed.

Summary of information for individual species and sites. The rows refer to the different sampling types, band, quad and rpc. Column 1 gives the number of species in the group. Columns 2-4 summarize a matrix which gives the number of years of observation for each combination of a species and a site. (An observation does not mean the species was found, only that it was sought.) Column 2 gives the average value in this matrix. Column 3 measures the variation among species: it is the SD of the species averages - i.e., for each species, we average the number of observations over sites, and then we take the SD of these averages. Column 4 measures variation among sites in the same way. Columns 5-7 summarize the matrix which gives the number of years of positive observation for each combination of a species and a site, in the same way. These two types of SD show that some species were observed, and/or observed to be positive, far less often than others (e.g., some species were always positive while others were never actually found!), but most species observed often at one site were observed often at all sites. Column 8 is the average of the standard ANOVA F-ratio used to test the null hypothesis that there is no temporal variation (and assuming that bands or quadrats in a given year are independent, with the same variance over years). It is roughly the ratio of the variance of the annual averages to the value that would be expected if there was no temporal variation, only sampling error. Column 9 is the average (over species-site combinations) of the averages (over years) of the coefficients of variation, i.e., of $CV = (SD \text{ among quadrats}) / (\text{average for the year})$. The smaller value for "band" might reflect the larger area sampled for these species.

| | <u>No.spp</u> | <u>No.yrs</u> | <u>SD.spp</u> | <u>SD.sit</u> | <u>Pos.yrs</u> | <u>SD.spp</u> | <u>SD.sit</u> | <u>F-ratio</u> | <u>CV%</u> |
|------|---------------|---------------|---------------|---------------|----------------|---------------|---------------|----------------|------------|
| band | 16 | 14.18 | 1.58 | 0.97 | 7.13 | 4.15 | 1.28 | 5.14 | 70 |
| quad | 28 | 10.03 | 6.52 | 0.69 | 6.54 | 5.59 | 1.07 | 6.39 | 239 |
| rpc | 37 | 10.69 | 5.50 | 0.64 | 7.99 | 5.33 | 0.96 | 10.75 | 220 |

Summary of correlations between site pairs. For each site pair, the correlation for each species, and the number of years it was based on (the number of years when the species was observed at both sites), was obtained where possible. It is not possible if there was no year in which both sites were sampled for the species. Then the mean (over species), SD and number of the correlations, and the mean number of years, was obtained, giving four numbers for each of the 120 site pairs. This table gives the average (over site pairs), SD, minimum and maximum of the means, the average and SD of the SDs and of the years, and the average number of species. The rows refer to the different sampling types, band, quad and rpc. Each type was summarized three times: once using all correlations, again using only correlations where both species were non-zero in at least 5 years, and again using only correlations where both species were non-zero in at least 10 years. (Note: raising the number of non-zeros removes correlations from the list for each site-pair, so the site-pair's average can go either up or down; this is why the minimum can get smaller and the maximum can get bigger when more non-zeros are required.)

| | <u>AveCorr</u> | <u>(SD)</u> | <u>Min.Ave</u> | <u>Max.Ave</u> | <u>AveSD</u> | <u>(SD)</u> | <u>AveYrs</u> | <u>(SD)</u> | <u>No.spp</u> |
|--------|----------------|-------------|----------------|----------------|--------------|-------------|---------------|-------------|---------------|
| band0 | 0.11 | (0.13) | -0.09 | 0.49 | 0.32 | (0.07) | 14.04 | (1.42) | 10.96 |
| band5 | 0.11 | (0.16) | -0.22 | 0.55 | 0.32 | (0.11) | 14.15 | (1.38) | 5.95 |
| band10 | 0.12 | (0.22) | -0.82 | 0.65 | 0.29 | (0.14) | 14.31 | (1.26) | 3.46 |
| quad0 | 0.18 | (0.15) | -0.15 | 0.56 | 0.38 | (0.07) | 13.76 | (1.70) | 16.79 |
| quad5 | 0.22 | (0.16) | -0.20 | 0.60 | 0.33 | (0.06) | 15.00 | (1.42) | 10.12 |
| quad10 | 0.24 | (0.18) | -0.20 | 0.64 | 0.32 | (0.09) | 15.30 | (1.39) | 6.81 |
| rpc0 | 0.18 | (0.10) | -0.11 | 0.52 | 0.35 | (0.04) | 12.82 | (0.91) | 27.92 |
| rpc5 | 0.20 | (0.11) | -0.11 | 0.52 | 0.33 | (0.04) | 13.51 | (1.12) | 20.23 |
| rpc10 | 0.19 | (0.13) | -0.16 | 0.54 | 0.31 | (0.06) | 13.85 | (1.09) | 13.98 |

Summary of correlations between neighboring sites. The site groups 6 and 7, 9 and 10, and 14-16, are closer together than other sites pairs. If distance is an important factor in whether one site tracks another, the correlations among pairs in these groups should be higher than most. This table gives the average (over species within a group) of the correlations for these pairs, and the rank of this average among the averages for all 120 site pairs (rank = 1 is the highest correlation). In each case, the first column considers all available correlations (those based on 2 or more years when the species was sought at both sites) and the second considers only correlations based on 10 years or more.

| | Band, ≥ 2 | | Band, ≥ 10 | | Quad, ≥ 2 | | Quad, ≥ 10 | | rpc, ≥ 2 | | rpc, ≥ 10 | |
|-------|----------------|-------------|-----------------|-------------|----------------|-------------|-----------------|-------------|---------------|-------------|----------------|-------------|
| | <u>Ave</u> | <u>Rank</u> | <u>Ave</u> | <u>Rank</u> | <u>Ave</u> | <u>Rank</u> | <u>Ave</u> | <u>Rank</u> | <u>Ave</u> | <u>Rank</u> | <u>Ave</u> | <u>Rank</u> |
| 06:07 | 0.13 | 51 | 0.13 | 55 | 0.23 | 45 | 0.21 | 52 | 0.24 | 31 | 0.23 | 27 |
| 09:10 | 0.49 | 1 | 0.49 | 1 | 0.35 | 17 | 0.44 | 6 | 0.52 | 1 | 0.51 | 1 |
| 14:15 | 0.11 | 57 | 0.16 | 38 | 0.56 | 1 | 0.53 | 1 | 0.44 | 2 | 0.40 | 3 |
| 14:16 | -0.01 | 96 | 0.04 | 77 | 0.49 | 3 | 0.45 | 5 | 0.26 | 22 | 0.24 | 26 |
| 15:16 | 0.02 | 83 | 0.00 | 94 | 0.42 | 8 | 0.38 | 10 | 0.24 | 33 | 0.20 | 45 |

Effects of Biologically Degraded Oil on Marine Invertebrate and Vertebrate Embryos and Larvae

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Background

The removal of volatile compounds through weathering of crude oil results in the release of low boiling point aromatic and saturated hydrocarbons. It has been thought that those components hold the greatest toxicity to marine life (Capuzzo, 1987; Galt *et al.*, 1991; Payne *et al.*, 1991; Venkateswaran *et al.*, 1995). Although biodegradation of crude oil can be considered a component of the weathering process, the process continues well after initial weathering and the elimination of volatile compounds has occurred. Known results of this continued microbial degradation include a measurable decrease in sediment crude oil along with a measurable organic enrichment in those sediments (Spies, 1987). Recently, studies (including our laboratory) have demonstrated that a by-product(s) of microbial degradation of artificially weathered Alaska North Slope crude oil is a ten fold increase in neutral water soluble hydrocarbons that exhibits significantly high toxicity to developing atherinid and clupeoid fish embryos (Middaugh *et al.*, 1996, 1998). Biodegradation of crude oil occurs in regions of natural seepage (e.g. Coal Oil Point) as well as in regions of oil production and transport where elevated populations of crude oil-degrading microbes are purported to exist (Spies, 1987). It can be assumed that the process of oil biodegradation in the Santa Barbara Channel near sites of natural oil seeps and non-catastrophic release (associated with oil production) is an ongoing process and that the products of that biodegradation are chronically present, resulting in profound long range implications to the biota of the area.

Progress to Date

This project has been determining the effects of water soluble components of biodegraded Santa Barbara crude oil on both invertebrate and vertebrate marine organisms, emphasizing the mechanisms utilized by some groups of organisms to tolerate relatively high concentrations of degraded petroleum compounds, and investigating the identity of the classes of compounds responsible for biological activity. While officially initiated 1 July, 1996, the project was not fully implemented until November, 1996, which was the time funding was received. Because of this we have asked for and been granted a one year no cost extension to complete the project. Below we summarize progress to date on the project, including work accomplished since its inception.

Santa Barbara Channel crude oil was artificially weathered and biodegraded using microbes enriched for their oil degrading ability. Artificially weathering was accomplished by autoclaving the oil at 374°C and distilling at 1 atm, after which it was stored in aliquots at -70°C. Microbes for biodegradation were obtained by enrichment of a seep sediment starter that was collected from Coal Oil Point in collaboration with UCSB researchers. To enrich for the oil degrading microbes, the seep material was serially plated onto agar containing Bushnell-Haas nutrients, seawater, and 0.2% weathered-oil three times. These serial enrichment steps yielded a primarily a morphologically uniform gram negative bacterial

population. The resultant microbial populations from the third inoculations were stored in aliquots at -70°C

Biodegraded oil was obtained by co-incubating artificially weathered oil (0.2% w/v) and our enriched culture of microbes from Coal Oil Point for 14 days at 15°C . Control flasks contained $0.45\ \mu\text{m}$ filtered seawater, 0.2% weathered crude oil, but lacked the microbes. Following incubation, both microbially degraded and non-degraded oil-water mixtures were serially filtered through $0.7\ \mu\text{m}$, $0.45\ \mu\text{m}$, and $0.22\ \mu\text{m}$ cutoff filters to remove particulate oil materials and microbes. The resultant filtrate from the seawater/oil that had contained the microbes, termed the biodegraded water-soluble fraction (BWSF), possessed a distinctive yellow coloration and a much reduced pH ($\text{pH}=5-5.7$). The filtrate from the seawater/oil that did not contain microbes, denoted as the nondegraded water-soluble fraction (NWSF), was a clear liquid with a pH of approximately 7.8.

The biological effects of BWSF and NWSF were assessed for their toxicity using embryos of the white sea urchin (*Lytechinus anamesus*), Pacific oyster (*Crassostrea gigas*), the fat innkeeper worm (*Urechis caupo*), and herring embryos/larvae (*Clupea pallasii* and *C. harengus membras*). Sea urchin and herring embryos were by far the most sensitive with adverse developmental effects being observed at concentrations of the degraded oil fraction

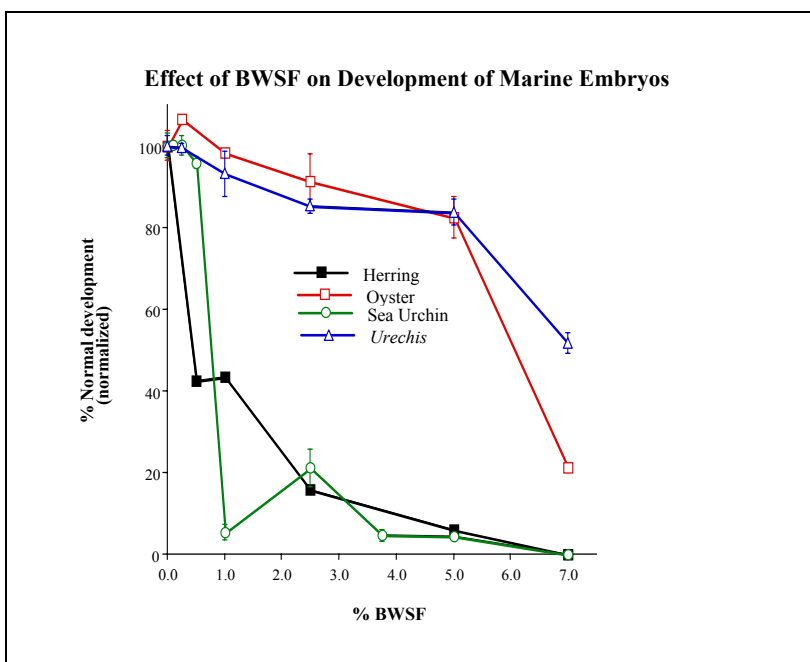


Figure 1: Responses of herring, sea urchin, oyster, and *Urechis* embryos to BWSF fraction. Note that *Urechis* and oysters are an order of magnitude less sensitive than herring and sea urchin embryos.

near 0.1% (v/v) (Fig. 1). Since the starting concentration of crude oil was 0.2% (20 ppm), the lowest effective concentration (0.1% of BWSF) translated into the degradation products of approximately 20 ppb oil. The non-biodegraded control, NWSF, showed effects only at concentrations near 10% (2 ppm). Both *Urechis* and oyster embryos were significantly less affected by BWSF, with adverse effects only being observed near concentrations of 10% and 5%, respectively. The NWSF fractions only affected embryonic development when present at one to several orders of magnitude greater than BWSF. For example, development of *L. anamesis*, was only affected at concentrations greater than or equal to 5-10% NWSF (1-2 ppm) and there was very little or no effect on *Urechis* and *C. gigas* embryo development

except at near full strength concentrations (20 ppm). The mollusk embryos (*C. gigas*) exhibited a response in between those of sea urchins and *Urechis*. This suggests that the mechanisms involved in tolerance may also be somewhat between sea urchin embryos and *Urechis* embryos. A composite of normal and abnormal larvae of the three invertebrate species is shown in Figure 2.

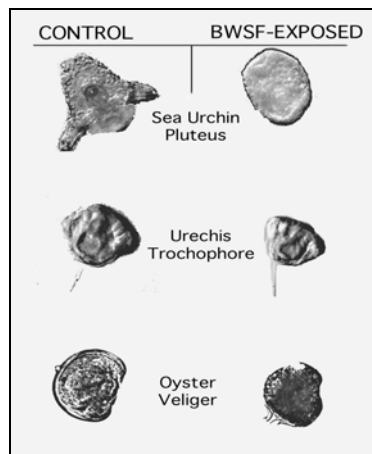


Figure 2: Sea Urchin (*L. anamesus*), *Urechis*, and oyster (*C. gigas*) larvae which were exposed to 5% BWSF or control medium immediately after fertilization and cultured to the larval stage. Note the severe abnormalities in the sea urchin pluteus larva, while the *Urechis* trochophore and the oyster veliger larvae are relatively normal at the 5% concentration of BWSF.

We have found that the neutral extractable fraction of weathered and biodegraded Santa Barbara Channel crude oil, is not responsible for toxicity, rather the more polar fraction is implicated. Work is continuing to further fractionate the polar compounds from lyophilized samples using the sea urchin embryo system to guide the fractionation efforts.

We have examined and delineated a cellular mechanism, the activity of which correlates with the differences in BWSF tolerance of *L. anamesus*, *U. caupo*, and *C. gigas* embryos/larvae. That mechanism is the activity of the ATP-dependent multidrug resistance (MXR) transporter (a.k.a. p-glycoprotein or MDR transporter; molecules responsible for rapid development of resistance to chemotherapeutic drugs in mammalian cells). The MXR transporter of invertebrates is involved in resistance to xenobiotic and natural compounds or toxins that possess hydrophobic characteristics (Kurelec, 1992, 1997). *Urechis* is a mud flat inhabitant whose developmental and adult life stages are exposed to a variety of natural and anthropogenic compounds that are hydrophobic. Not surprisingly, *U. caupo* embryos possess an active MXR transporter that protects them from environmental toxins (Toomey and Epel, 1993). Oysters from contaminated sites have been shown to have increased MXR transport activity (Minier et al., 1993), suggesting that MXR activity may be an inducible mechanism for resistance to organic contaminants. *L. anamesus* embryos do not possess the transporter (as has been shown in other sea urchin embryos; Toomey and Epel, 1993).

Western blot analyses of embryo and larval polypeptides was conducted using an antibody cocktail that included the monoclonal antibody to the cytoplasmic domain of human *mdr1-3* protein. Preliminary blots reveal that the antibody does not recognize polypeptides from *L. anamesus*, but does cross-react with a 240 kilo Dalton polypeptide in embryos and larvae of both *Urechis* and *C. gigas* (Fig. 3).

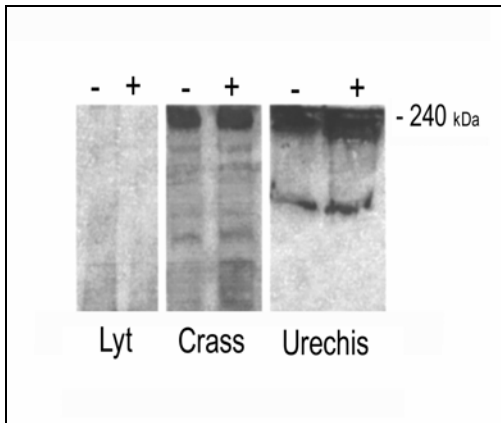


Figure 3. Pre-hatch embryos (—) and hatched larvae (+) were subjected to SDS-PAGE, blotted to nitrocellulose, and labeled with an antisera mixture containing antibodies to human *mdr1-3* protein. Neither *Lytechinus anamesus* (**Lyt**) pre-hatch embryos (—) nor larvae (+) possessed polypeptides that were recognized by any the antibodies. Embryos and larvae of both *Crassostrea gigas* (**Crass**) and *Urechis caupo* (**Urechis**) did possess an antibody-recognized polypeptide that migrated at 240 kilo Daltons, the approximate molecular weight rang of the human *mdr 1-3*

To investigate whether MXR transporter activity was involved in BWSF tolerance, we used a competitive fluorescence assay that measured the transporter’s ability to export a mildly hydrophobic, non-toxic fluorescent compound, rhodamine (Toomey and Epel, 1993). The prediction was that if MXR was involved in the export of BWSF components, and thus tolerance, it would competitively inhibit MXR ability to export rhodamine. The ability of *Urechis*, *C. gigas*, and sea urchin larvae to export rhodamine was quantitated fluorometrically and visualized with fluorescence microscopy in the presence or absence BWSF. Our results confirm that *L. anamesus* larvae do not possess the MXR transporter, while *Urechis* and oysters do show transporter activity (Fig. 4). Furthermore, the data showed that BWSF did inhibit the MXR transporter’s ability to export rhodamine in *Urechis* and *C. gigas* embryos. *C. gigas* embryos/larvae possessed transporter activity, but at lower levels than those of *Urechis*. Thus, the presence or absence of the MXR transporter is likely to be the major mechanism responsible for tolerance or sensitivity of organisms to BWSF.

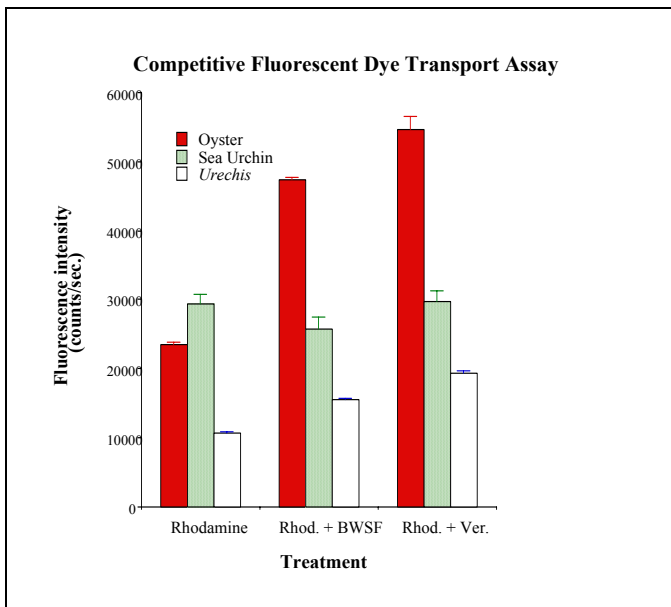


Figure 4: Quantitative fluorescence measurements of rhodamine dye in seawater (“Rhodamine”), seawater + 5% BWSF (“Rhod + BWSF”), and a positive control (“Rhod + Ver.”), verapamil (50 μ M). Note that for *Urechis* and oyster embryos, there is a significant increase in fluorescence in the presence of BWSF and verapamil. There is no change in sea urchins, as MXR transporter is not present.

During the past year we demonstrated that the ability of the MXR transporter to eliminate BWSF components is a function of the concentration of other “naturally occurring”

substrates that exist in the seawater, that is, compete with BWSF for transport by the MXR. Seawater from two sites in Tomales Bay, subject to loads of organic input due to freshwater runoff from surrounding agricultural land, and an open coast control site were utilized. Site 1 was a region of the bay near a commercial oyster facility where tidal currents provided a diurnal exchange of water. Site 2 was a marshy inlet of the Bay that receives winter and spring runoff from a cattle ranch and where tidal exchange is reduced. Site 3, the control, was Horseshoe Cove, which is on the open coast (not in Tomales Bay) and exposed to open ocean waves and tidal fluxes. The relative concentrations of organic molecules in the seawater samples was determined by measuring absorbance at 280 nm (wavelength at which conjugated benzene rings absorb) on a spectrophotometer. Only background levels were recorded from the Site 3 Horseshoe Cove samples (Fig. 5). Tomales Bay Site 1 registered an organic concentration that was two orders of magnitude greater than the Horseshoe Cove control site. Site 3 contained an organic load that was approximately 2.5 times higher than Site 2. Thus we were measurable differences in the organic molecule contents of the seawaters from the three sites.

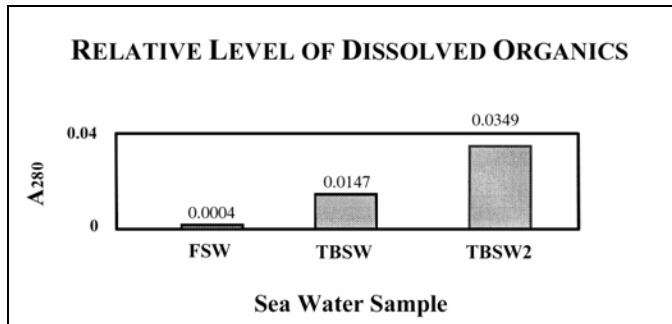


Figure 5. Open coast seawater (FSW) from Horseshoe Cove, and sea water from two sites in Tomales Bay (TBSW & TBSW2) were compared for relative concentrations of organics based on their ability to absorb at 280 nm.

To determine whether organic content (which could be from a variety of sources including agricultural or petroleum sources) modulated the function of MXR transporter activity, we analyzed the ability of the larval *C. gigas* to export rhodamine in these different seawaters using the rhodamine dye efflux assay. The ability of larvae to export the dye correlated with the amount of organic contamination in the seawater (Fig. 6). Seawater from the site with the lowest organic load had the least effect on dye export from larvae while the seawater with the highest organic load inhibited dye efflux to the greatest extent.

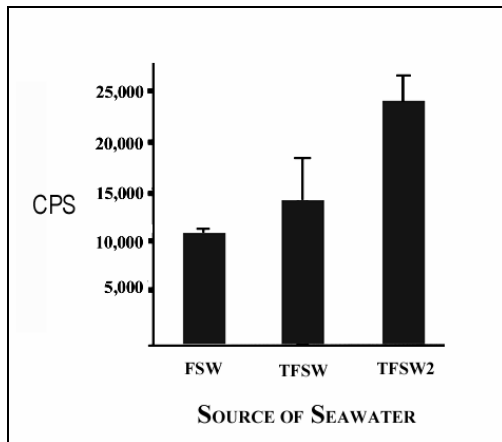


Figure 6. *C. gigas* veliger larvae were cultured in open-coast seawater (FSW), Tomales Bay seawater containing 0.0147 absorbance units of organic components (TFSW), and Tomales Bay seawater containing 0.0349 absorbance units of organic components for 36 hrs. The ability of larvae to export rhodamine in the dye efflux assay was then scored as relative fluorescence units (CPS).

The importance of organics in seawater was demonstrated by a set of experiments in which *C. gigas* larvae were exposed to BWSF in the different seawaters. BWSF inhibited

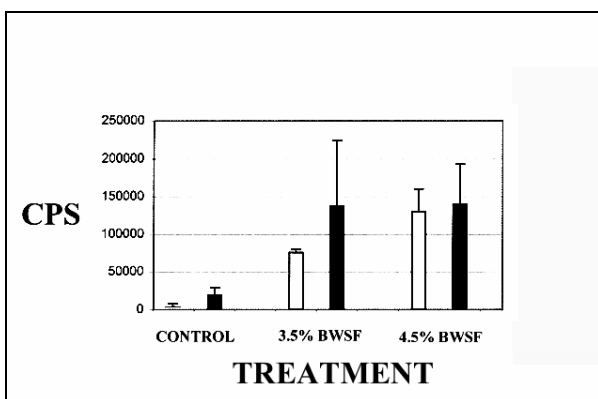


Figure 7. Larvae incubated in Tomales Bay seawater (■) containing 3.5% BWSF, 4.5% BWSF, or Verapamil possessed elevated levels of fluorescence (CPS) compared to those in open ocean seawater (□).

larvae's ability to export rhodamine (Fig. 7). Controls (open coast and the 0.0349 A Tomales Bay seawaters) yielded similar results to those described in Figure 6. The addition of BWSF, however, produced two observed changes. First, the ability of larvae to export rhodamine declined in both seawaters and second, larvae in the lower concentration, 3.5%, of BWSF were less able to export rhodamine in the Tomales Bay seawater. At the higher BWSF concentration, 4.5%, there was no significant difference in the responses of larvae in the clean and organically enriched seawaters. The physiological ability of larvae to withstand BWSF, as well as export rhodamine, was also impaired by the organic load in the seawater. In the presence of BWSF, larvae either ceased development or developed abnormally. In a separate, but parallel study, we have also found that the level of MXR transporter present in oyster adults is greater in animals that inhabit organically rich seawater than in those living in seawater with lower organic loads

As previously described, the ability of the MXR transporter to rid cells of hydrophobic toxic compounds, is functionally similar to multidrug resistance (MDR) in humans. The biochemical similarity is evidenced by the fact that antibodies to a human MDR-glycoprotein, *mdr1-3*, recognize the MXR transporter in both *Urechis* and *C. gigas*. The MDR transport proteins have been implicated in transport of metabolites, ions and both endogenous and exogenous toxins (Gottesman and Pastan, 1988; Horio et al, 1988; Sarkadi et al, 1992). To unequivocally demonstrate that the MXR transporter is responsible for BWSF tolerance, we examined two variations of a human fibroblast cell line, NIH-3T3 cells. One was a non-transfected 3T3 cells that did not possess the MDR gene and thus was unable to express MDR transporters, and the second was an MDR-transfected subline of 3T3 cells that does express the MDR transporter. NIH-3T3 (ATCC) cells were thawed from liquid nitrogen and cultured in standard media (high glucose DMEM (Gibco-BRL) supplemented with 10% fetal bovine serum (Hyclone) and sodium 110mg/liter pyruvate) through 2 to 3 passes, and harvested by trypsin-EDTA treatment. After a two day recovery, cells were then cultured in 30 mm Falcon dishes either in the presence or absence of BWSF at concentrations that ranges from 0.5% to 5% of the culture media for a period of seven days. Differential growth of cell cultures was used as a determinate for whether or not BWSF had an effect on 3T3 cells.

At the start of each experiment, just under 4×10^5 cells were added to dishes that contained 0.5, 1.5, 2.5, or 5% BWSF. The differential sensitivity of the MDR and non-MDR 3T3 cells to BWSF mirrored that which we observed when comparing echinoderm and echiuroid embryos. Two significant responses to BWSF were demonstrated with the transfected 3T3 cells. First, transfected 3T3 cells were capable of withstanding concentrations that were an order of magnitude greater than were the non-transfected cells, similar to that observed between sea urchin and *Urechis* embryos, confirming that tolerance is in part due to the presence of a MXR/MDR transporter. Second, the effect of BWSF on cells that utilize an MXR transporter is cumulative over time, that is cells or organisms appear to lose the ability to tolerate MXR substrates over time. This is demonstrated in Fig. 8. After five days of co-incubation, increase in cell number in 0.5, 1.5 or 2.5% BWSF was not significantly different from controls (not shown) or from each other. Only cells in the cultures containing 5% BWSF exhibited a significant difference in the 5 day cell number (compared with cultures of controls and the lower BWSF concentrations). Continued exposure to BWSF lowers the effective dosage from 5% to 2.5% (Fig. 8). After seven days of co-incubation, cell growth was inhibited significantly in both 5% and 2.5% BWSF. Positive cell growth was obtained in the two lower concentrations (0.5% & 1.5%), but not in the 2.5 and 5% BWSF exposures. Again, these tolerated BWSF concentrations are similar to those that can be withstood by *Urechis* and *C. gigas* embryos, an order of magnitude greater than can be tolerated by invertebrate and mammalian systems that do not possess either the MDR or MXR transporter.

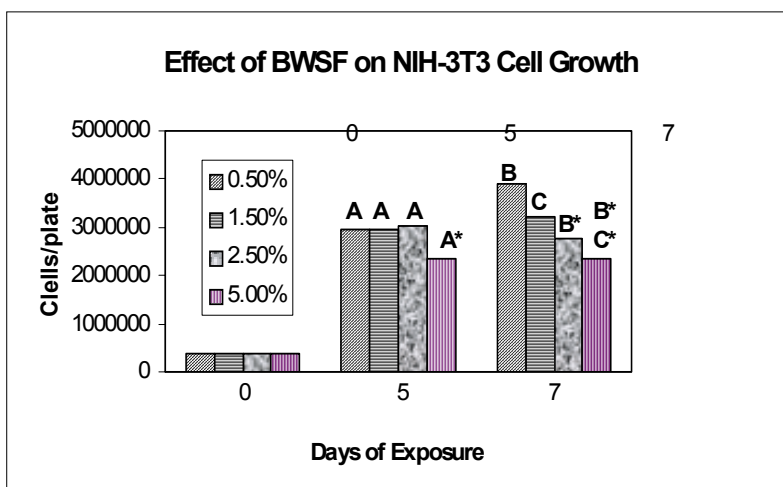


Figure 8. NIH-3T3 cells, transfected with the MDR gene, were grown on plates containing either 0.5, 1.5, 2.5, or 5% BWSF. The numbers of cells in each treatment were scored at 5 and 7 days of exposure.

A-A* = ANOVA ($P < 0.05$)

B-B* = ANOVA ($P < 0.01$)

C-C* = ANOVA ($P < 0.05$)

Using both western blot and dye exclusion approaches, we plan to assess embryo and tissue sample from organisms collected near seep sites in the Santa Barbara Channel and compare them to the same species from sites which are not enriched for petroleum hydrocarbons. In particular, we are pursuing the question of whether sea urchins in the vicinity of seep sites express MXR protein. This would be a remarkable finding since it is currently believed that echinoderms are one of the only groups of organisms which do not express MXR protein. While the gene may be present, the protein is not readily expressed under short-term xenobiotic exposures (preliminary observations).

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Detecting Ecological Impacts: Effects of Taxonomic Aggregation in the Before-After/Control-Impact Paired Series Design

Principal Investigators: **Sally Holbrook**, Department of Ecology, Evolution and Marine Biology, University of California, Santa Barbara, CA 93106, **Mark H. Carr**, Department of Biology, University of California, Santa Cruz, CA 95064, **Craig W. Osenberg**, Department of Zoology, University of Florida, Gainesville, FL 32611-8525.

The third year of this study involved three overall objectives listed and addressed separately below. Two objectives include database development and data analysis for three separate datasets collected for three studies: the Carpinteria produce water discharge, Gaviota produce water discharge, and the San Onofre Nuclear Generating Station (SONGS) cooling water intake and discharge study conducted by the Marine Review Committee (MRC). A third objective is the development and analysis of size frequency distributions of targeted species from the Gaviota and Carpinteria studies. The status of each of the overall objectives is presented for each of the three studies. In addition to the objectives below, we have also arranged to have the benthic samples archived at the Natural History Museum of Los Angeles County.

Objective 1: Size frequency analyses of Gaviota and Carpinteria benthic samples

Gaviota biocores: Four species of polychaetes (*Apoprionospio pygmaea*, *Levinsenia gracilis*, *Nephtys cornuta*, and *Spiophanes missionensis*), four species of crustaceans (*Apoprionospio pygmaea*, *Levinsenia gracilis*, *Nephtys cornuta*, and *Spiophanes missionensis*), and three species of molluscs (*Parvilucina tenuisculpta*, *Tellina carpenteri*, and *Rocheportia tumida*) were removed from the biocore samples for size frequency analysis during Year 1. No species was consistently numerous among the Gaviota emergence or re-entry traps to allow for size frequency analysis.

Carpinteria Biocores: Four species of polychaetes (*Apoprionospio pygmaea*, *Levinsenia gracilis*, *Goniada littorea*, and *Spiophanes duplex*), four species of crustaceans (*Amphideutopus oculatus*, *Campylaspis hartae*, *Foxiphalus obtusidens*, and *Rutidermi rostratum*) and three species of molluscs (*Parvilucina tenuisculpta*, *Tellina carpenteri*, and *Rocheportia tumida*) were removed from the biocore samples for size frequency analysis. No species was consistently numerous among the Carpinteria emergence or re-entry traps to allow for size frequency analysis.

Size frequency samples are being processed in Carr's lab at UCSC. Samples are imaged and digitized with a video camera, frame grabber, and Adobe Photoshop software (Mac and PC-based systems). Images are measured using NIH imaging software. To date, over 200 volunteer person hours have generated 563 images representing over 70 percent of the mollusc samples from the Gaviota and Carpinteria studies.

Objective 2: Database development for MRC and MMS/UC SCEI samples

Data acquisition, transcription and database development

Prior to any transcription of species identities and abundance data into any database, a master species list had to be compiled with the original and revised taxonomic designations for the pre-existing MRC-SONGS species list. This master species list includes all molluscs, polychaetes, crustaceans, and miscellaneous species found in all three studies (MRC, Carpinteria and Gaviota). All species must also be assigned to the appropriate phylum, class, order, and family designations. All species must also be assigned an individual species code, compatible with the pre-existing codes in the original MRC-SONGS species list. A large number of taxa were new to the existing species list from the MRC surveys, so they have been assigned species-level codes compatible with pre-existing codes assigned to the MRC data. Lovell and Associates supplied the codes, and have reviewed them and the taxonomic classifications to insure that the proper codes were used and the classification of animals is current. The overall goal requires extensive coordination across all three datasets. Although the task is nearly 100% complete, we have encountered some problems with consistency and are working to resolve these few remaining conflicts.

In addition to the master species list, individual databases for both Gaviota and Carpinteria for each sampling method (emergence traps, re-entry traps and biocores) have been compiled as Excel spreadsheets for eventual transformation to SAS datasets. The Carpinteria biocore databases are still being compiled at Osenberg's lab as data are transcribed to the Excel spreadsheets. These databases include appendices with information for interpreting the codes used in each database, a process trail indicating personnel involved in the identifications and data transcription and entry, and any alterations to the databases subsequent to their original formulation.

Taxonomic and ecological functional group assessment.

After several efforts were made to collaborate with Dr. Karen Green, who had agreed to provide functional designations for the taxa, we have determined that such a collaboration is highly unlikely. Thus, we will focus our efforts on the effects of taxonomic aggregation rather than functional aggregation. However, some analyses based on ecological functional aggregations can be done from existing information in the literature and based on broad phylogenetic differences in trophic relationships.

Objective 3: Analysis of MRC and MMS/UC SCEI samples

Analysis of each of the three datasets requires complete and updated taxonomic data, as well as functional group designations. This information is not yet available. We are in the process of finalizing the taxonomic information and master species list, updating the datasets, and proofing the entire set of files. As soon as this is completed, we will begin our analyses of the patterns of spatial and temporal variation and the influence of taxonomic aggregation for the MRC, Gaviota and Carpinteria studies. This is the primary task for this coming year

of the project. Due to delays in the other objectives, we have funds remaining to cover these activities and have requested (and had approved) a 12-month no-cost extension to help ensure completion of this work.

Effects of an Oil Spill on Multispecies Interactions that Structure Intertidal Communities

Principal Investigator: Peter Raimondi, Department of Biology, University of California, Santa Cruz, California 95460

Progress and Findings

The work on the original project stopped completely in November 1998 due to the inability of MMS to supply us with the produced water (PW) we required. As I have noted in the last 2 quarterly, we heard from Dave Panzer at MMS Camarillo that we were denied access to more PW by various oil companies. As I had no more supplies of PW, this effectively ended all our work with PW. As I have previously stated, I will complete a study, however it will not be the project MMS originally funded. The MMS-CMI director, Russ Schmitt has been fully appraised of the situation since late 1998. It was a very unfortunate turn of events and efforts should be made so similar situations do not occur in the future.

Before I completely ran out of PW, I ran a series of field experiments in the Santa Cruz Harbour looking at the growth of an adult bryozoan, *Watisipora subtorquata*, after spiked exposure of competent larvae to sub-lethal doses of produced water. This was very successful.

We exposed the larvae to various concentrations of PW ranging from 0% to 10% of pre-diffuser levels, settled them under lab conditions, followed their early growth, out-planted them and monitored their growth and survival in the field. We also monitored other more subtle sub-lethal impacts such as competitive ability of the adults. Some of the PW concentrations were chosen to elicit behavioural responses from the larvae and then allow us to follow these larvae/adults to look for longer-term effects. They may be unrealistically high compared to a common field exposure.

The larvae consistently swam less, settled less and showed less movement of any kind under the influence of higher concentrations of PW. However, there was little difference in the activity of the larvae within hours of exposure to PW if they were washed in clean, filtered seawater.

Larval mortality it tended to be in higher concentrations of PW and was visible after the first hours of exposure rather than during exposure.

There were small differences in adult mortality. However there was little evidence for strong sub-lethal effects on the growth or competitive abilities of *Watisipora subtorquata* adults. Where mortality occurred, it tended to be more for colonies exposed to concentrations of and above 10% pre-release levels. This result could have important implications for population demographics that we are currently modeling. We have further experiments studying other species of bryozoans that indicate similar, although not always the same results.

The same method and experimental design was used with two other local species of bryozoan, *Hippodiplosia insculpta* and *Schizoporella unicornis*. The data are being analysed now. The same method was also tried with larvae of the colonial ascidian *Botrylloides* spp twice in the summer of 1998 and once in 1999 with limited success. I also had good success culturing the

local polychaete worm, *Phragmatapoma californica* and had scheduled experiments with PW and these larvae for September 1998. These experiments went no further than the pilot stage due to the problems outlined above.

After the PW incidents, I forged a collaboration with Dr Gary Cherr from the Bodega Marine Laboratory of UC, Davis and one of his doctoral students, Amro Hamdoun. They supplied me with other sources of oil-based toxicants to use in our experiments. Initially, I am used some lyophilized PW he had in storage to round off my previous PW studies. These had mixed success. We are also collaborating on work into the sub-lethal effects of a bacterial degraded crude oil fraction (BWSF). It is progressing well and I am using the sand-tube worm, *Phragmatapoma californica*, for this work.

Future plans

Experiments will continue this summer using the local polychaete worm, *Phragmatapoma californica* and BWSF. The rest of the time is being spent analysing data and writing papers for submission.

If I am able to obtain some PW, I have some small and quick experiments I would still like to run to round out the last, unfinished set of experiments.

Inventory of Rocky Intertidal Resources in San Luis Obispo County and Northern Santa Barbara County

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

Summary of Progress and Project Goals

This report summarizes the accomplishments of the Inventory of Rocky Intertidal Resources for San Luis Obispo and Northern Santa Barbara Counties from July 1998 to July 1999. 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 1998. Five additional sites were established in 1995 for San Luis Obispo County (SLO). The combination of previous and current year surveys in the two counties has resulted in a total of 15 samples for NSB sites, and 8 samples for SLO sites.

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. Permanent plots are also established for large motile species such as owl limpets, black abalone, and seastars. Line transects are used to estimate the cover of surfgrass. A video overview 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.

The fieldwork conducted this past fall and spring was quite successful. Table 1 summarizes the field activities for both counties. The spring 1999 sampling of Government Pt. (an NSB site) proved to be a bit challenging as access to the surrounding private land has been denied to all researchers working in the area. Fortunately, the site can also be reached by boat when sea conditions are calm. The late spring sampling date for Government Pt. listed in Table 1 resulted from the need to wait until conditions were calm enough for safe entry and exit to and from the site. Because Government Pt. was sampled late, spring 1999 data are not yet available for species sampled using photoplots. Photoplot slides will be scored during the next quarter. Data for all other sites have been entered and analyzed for all work completed through spring 1999. In addition, a three-year project report, summarizing data from spring 1992-Spring 1998 for sites in San Luis Obispo, Santa Barbara, and Orange Counties, was recently completed for the Minerals Management Service.

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

| Dates | County | Activity |
|------------------|------------------------|--------------------|
| 11/3-11/6 | San Luis Obispo | Fall 1998 sample |
| 10/8, 12/2-12/5 | Northern Santa Barbara | Fall 1998 sample |
| 2/26-2/28, 5/19 | Northern Santa Barbara | Spring 1999 sample |
| 3/14-15, 3/17-18 | San Luis Obispo | Spring 1999 sample |

A species by species summary of the results of the past year's monitoring follows. Anemones, (*Anthopleura elegantissima*), were sampled at only one NSB site, and showed a slight decrease in percent cover (approximately 5%) when compared to previous years. Barnacle cover (*Chthamalus* spp. & *Balanus* spp.) has experienced a gradual decline over time at all sites in both counties. This trend continued in the fall 1998/spring 1999 (F98/SP99) sampling period. This general decline is likely due to a gradual die-off of adult barnacles accompanied by low recruitment of new individuals into the communities. The gooseneck barnacle, *Pollicipes polymerus*, has experienced almost no change in percent cover over time at the one NSB site where it is sampled. Mussel cover (*Mytilus californianus*) remained high at nearly all SLO and NSB sites. Two exceptions were Stairs (an NSB site), where a decline of approximately 30% occurred, and Shell Beach (SLO) where mussels declined in cover by over 50%. Cover of the rockweed, *Pelvetia compressa*, remained fairly constant over time at all but one of the seven sites where it was sampled. At Stairs (an NSB site) *Pelvetia* cover has been gradually declining, and continued to decline during the F98 and SP99 samples. Another species of rockweed, *Hesperophycus harveyanus*, experienced sharp declines prior to the F98/SP99 sampling period at the two SLO sites where it was sampled. This decline appeared to level off during these most recent samples, and cover was approximately 35% at Pt. Sierra Nevada and 15% at Cayucos (down from an initial cover of approximately 90% at both sites). A slight decrease in cover was noted for *Endocladia muricata* during the F98/SP99 sampling period at all sites where this turfweed was sampled. *Endocladia* cover was greater in spring than fall at all sites—a seasonal dynamic that holds true for nearly all previous samples. The red alga, *Mastocarpus papillatus*, showed an opposite seasonal trend at one SLO site, with higher cover in the fall than the spring. At the other site where *Mastocarpus* was sampled, (also in SLO), a decreasing trend was observed, with cover for the F98/SP99 sampling period lower than all previous samples. Cover of *Mazzaella* spp., another red alga, appeared to be relatively stable over time, with no substantial change in the F98/SP99 sampling period. Surfgrass cover (*Phyllospadix* spp.) remained high over time at all sites except Stairs (NSB), where plots were decimated by the 1997/98 El Niño storms. Recovery at this site is expected to be slow, as *Phyllospadix* is known to be a poor recruiter. Seastar numbers have fluctuated at most sites over time, and counts for the F98/SP99 samples did not appear to be abnormally high or low at any site. The owl limpet, *Lottia gigantea*, experienced increases in the number of individuals per 3.14 m² plot at all sites where this species was sampled. Increases ranged from slight (~5 individuals/plot) to large (~35 individuals/plot), and were attributed to an increase in the number of small limpets present in plots (i.e. increases were due to recruitment, not immigration of adults from outside plots).

A final important occurrence in the F98/SP99 sampling period was the continued decline of black abalone (*Haliotis cracherodii*), at Purisima Pt. (northernmost NSB abalone site) due to the fatal condition termed “withering syndrome.” Abalone populations south of Purisima Pt. have crashed to near-extinction, and withering syndrome appears to be progressively making its way up the coast. Purisima Pt. was the last known intertidal area where black abalone were found in extremely high abundance. Without large source populations from which recruitment can occur, it is doubtful that areas devastated by withering syndrome will recover. On a brighter note, higher than average numbers of juvenile black abalone were found at Pt. Sierra Nevada (northernmost SLO site) during the F98/SP99 period. Abalone populations at SLO sites are not nearly as large as historic populations at NSB sites (or those once present further south on the Channel Islands), but if they continue to be healthy, perhaps recruits from these northern areas will eventually reach the withering syndrome devastated areas to the south.

Inventory of Rocky Intertidal Resources in Southern Santa Barbara and Ventura Counties

Principal Investigator: Richard F. Ambrose, Department of Environmental Health Sciences, University of California, Los Angeles

Project Summary:

Prior to this report period, the inventory of Ventura County rocky intertidal monitoring sites was supported by funds from the California Coastal Commission. Despite various administrative and personnel issues, there was a successful transition to MMS funding during this period. In addition to the two established Ventura County sites, four southern Santa Barbara County sites were added to the UCLA team's sampling schedule. (Pete Raimondi's portion of the Inventory Program, at UC Santa Cruz, is responsible for the four northern Santa Barbara County sites.) During this period, all monitoring sites were sampled as scheduled. In addition, during this period we have performed various deferred tasks, including site maintenance, slide scoring, and data entry.

Near the end of the Coastal Commission project period, the project technician, Stephanie Sapper, left before a new technician could be hired and trained. For a variety of reasons, a new technician was not hired until January 1999. Consequently, the Fall 1998 sampling was completed with the assistance of Jessie Altstatt from UCSB. Jessie also helped revise and update the LA/Ventura County Rocky Intertidal Monitoring Handbook; this handbook is being edited and should be completed soon. In January 1999, Steven Lee was hired to work on the project. Steven received Bachelors and Masters degrees from UC Santa Cruz and has many years of experience in intertidal and subtidal monitoring and experimental ecology. During the first part of the year, Steven began working on the backlog of tasks that had accumulated during the absence of a project technician, including data, paperwork, and computer files that had to be located and organized. All of the Fall 1998 slides were scored and those data entered into the computer. In January, the photoplots at one of the LA County sites, White's Point, were re-shot because camera problems made the original slides unusable. Following the Spring 99 sampling, Steve scored the slides, entered the data, and generated updated graphs that included the last two sampling seasons. These graphs are included in this report (see below).

In the division of responsibilities for the Santa Barbara County sites, it was decided that the UCLA group would sample the four southern sites, score the photoplot slides, and enter those data into the computer. After that, the updated computer files for the southern Santa Barbara sites will given to the UCSC group for data management, analysis, and write up; this would allow the continued analysis and interpretation of the Santa Barbara County data by the UCSC group. This procedure was followed this year.

In March, the Spring 99 sampling was completed at the two Ventura County sites and the four southern Santa Barbara County sites (Table 1); we also sampled the two mainland LA County sites, although those are not included in the current funding. The two sites on Santa Catalina Island were not sampled this spring due to a lack of funding for the LA County sites. We hope to obtain funding for LA County in the future so that continued monitoring of these four sites can occur.

Table 1. Sampling schedule for Fall 1998 and Spring 1999.

| Location | Date | Researchers | Comments |
|----------------|--------------------|--|---|
| Mussel Shoals | Jan 4 | J.Altstatt, R.Ambrose, S.Adams, M.E.Dunaway | B5 plot missing; seastar bolts difficult to find; low sand level |
| Old Stairs | Dec 4 | J.Altstatt, R.Ambrose, L.Francis | Sand at moderate level |
| Paradise Cove | Dec 2 | J.Altstatt, R.Ambrose, | Sand level fairly high, some voids in mussel beds |
| White's Point | Dec 3, & Jan 18 | J. Altstatt, R.Ambrose, S.Lee | Many people, photos came out bad and returned to reshoot them |
| Bird Rock | Oct 7 | J.Altstatt, J.Engle, J.Wible, E.Erickson | |
| Little Harbor | Oct 8 | J.Altstatt, J.Engle, J.Wible, E.Erickson | |
| Alegria | March 1 | S. Lee, M. Wilson, M.Mcleary L.Slusher, Thomas ? | Some repairs made |
| Arroyo Hondo | March 2 | S.Lee, R.Ambrose, M.McCleary | Some repairs made |
| Coal Oil Point | March 29 | S.Lee, J.Altstatt | Heavy sand inundation: Surfgrass transects estimated |
| Carpinteria | March 16 | S.Lee, R.Ambrose, J.Altstatt, H. Leedy | All plots sampled; some repairs made |
| Mussel Shoals | March 17 | S.Lee, R.Ambrose, J.Engle, J.Altstatt, M.E. Dunaway, M.Mcleary | Repairs made, new video reference bolts established |
| Old Stairs | March 18 | S.Lee, R.Ambrose, J.Altstatt, M. Hill | Repairs made, new video reference bolts established |
| Paradise Cove | March 28 | S.Lee, R.Ambrose, J.Altstatt, S. Allen | All plots sampled |
| White's Point | March 19 | S.Lee, R.Ambrose | Reference bolt added |
| Bird Rock | April 21 | J.Altstatt, J.Engle, J.Wible, E.Erickson | One plot was encroached upon by someone else's experiment |
| Little Harbor | April 24 | J.Altstatt, J.Engle, J.Wible, E.Erickson | Some repairs made to bolts |

Spring sampling at all sites was successful. Prior to the sampling, we purchased a metal detector that enabled us to locate and recover bolts, including entire plots previously thought to be lost. As a result of our improved ability to locate bolts, a considerable amount of repair work was done this spring. The Coal Oil Point site was heavily inundated with sand during the Spring 99 sampling, and most of the plot/transect locations had to be approximated. At White's Point there has been substantial recruitment of the bay mussel, *Mytilus galloprovincialis*. These recruits appeared to be about a year old, perhaps the result of the recent El Niño event. It will be interesting to see how these mussels fare over time at this relatively exposed site.

The hiring of the new technician allowed us to renew our commitment to the barcacle recruitment monitoring, which were ongoing in the northern sites but discontinued in the southern sites. Recruitment sites have been re-established at Mussel Shoals and the two LA County sites. We have also added recruitment plates to two of the remaining three sites, Old Stairs and Carpinteria. Coal Oil Point does not have barnacle photo plots, so we will not be including that site.

During this report period, we have been discussing ways to improve video sampling. At a recent meeting of PI's, staff, and MMS personnel, it was decided that 35-mm still cameras would be used for one year as a possible alternative to the video procedures for obtaining an overview of the sites. In any case, we were not able to videotape White's Point, Paradise Cove or Coal Oil Point because we did not have an operational videocamera at the time. Only recently (July) did we receive a new video camera which will allow us to videotape all sites in the future. (The videocamera will also be used to document baseline and impact conditions in the event of an oil spill.) A revised video protocol is being compiled by Jack Engle, based on updated procedures and additional video reference points that were added in the Spring 99 sampling.

Future Plans:

One result from the recent MMS meeting of PI's was consensus on the need to properly archive the photoplot images. We recently received new slide scanner equipment that will enable us to store these images on compact discs, and will soon begin the task of scanning and archiving the photoplot image for all of the inventory sites. It is unknown at this point how long this process will take. We will also implement the new panoramic 35-mm photograph procedures during the Fall 99 and Spring 2000 sampling periods.

Data Summary For Ventura County:

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. *Cthalamus* cover has increased slightly at Mussel Shoals in the last two sampling periods and is currently among the highest levels we have seen during the study. At Old Stairs, the downward trend in *Cthalamus* cover seen throughout the study seems to be continuing despite an abrupt increase during the Fall 98 season.

Figure 2. *Mytilus* cover remains stable at both Mussel Shoals and Old Stairs with slight increases during the last two sampling periods. *Mytilus* cover at Mussel Shoals is consistently near an order of magnitude higher than at Old Stairs.

Figure 3. Endocladia cover at Old Stairs has been somewhat sporadic throughout the study. For the last three seasons, cover seems to have stabilized at a level that is relatively low compared to previous years.

Figure 4. *Anthopleura* cover at Mussel Shoals, while not statistically significant, appeared to be declining before this report period. In the last year, this pattern seems to have reversed, with a significant gain in cover present since its Spring 98 low. At Old Stairs, *Anthopleura* cover has dropped throughout the last year, continuing an apparent decline that has been present since the dramatic increase in Fall 97.

Phyllospadix Transects:

Figure 5. At Mussel Shoals, *Phyllospadix* cover within the transects experienced a marked decline following a peak in Fall 95. Within the last year, this decline appears to have been reversed with a slight increase over the Spring 98 low. *Egregia* cover has also increased slightly during the last two seasons.

Pisaster Plots:

Figure 6. The total number of *Pisaster* found at our two Ventura sites remains at very low levels compared to previous years. At Old Stairs, the decline has been severe: no sea stars were found at this site during the last sampling date. This could be related to the fluctuating sand levels at this site. At Mussel Shoals, the total number of *Pisaster* has remained nearly constant for the last three sampling seasons at a level that is one quarter that of previous years.

Lottia Plots:

Figure 7. *Lottia* abundance at Old Stairs has remained quite stable throughout the study with little change over the years. This is still true for the last two seasons, but abundance has increased and is currently at the highest level seen to date.

Figure 8. Mean *Lottia* size at Old Stairs has also remained stable throughout the study. During the last two seasons, mean size has declined somewhat, but the differences do not appear significant.

Southern California Educational Initiative

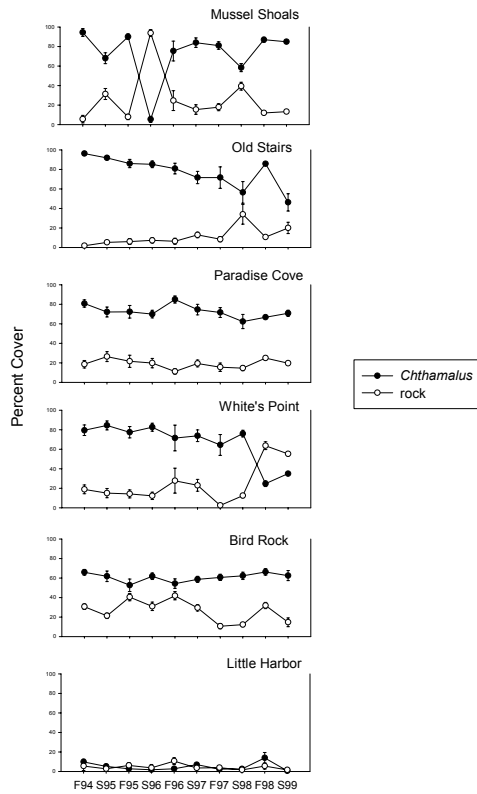


Figure 1. Trends in *Chthamalus* cover at all sites monitored.

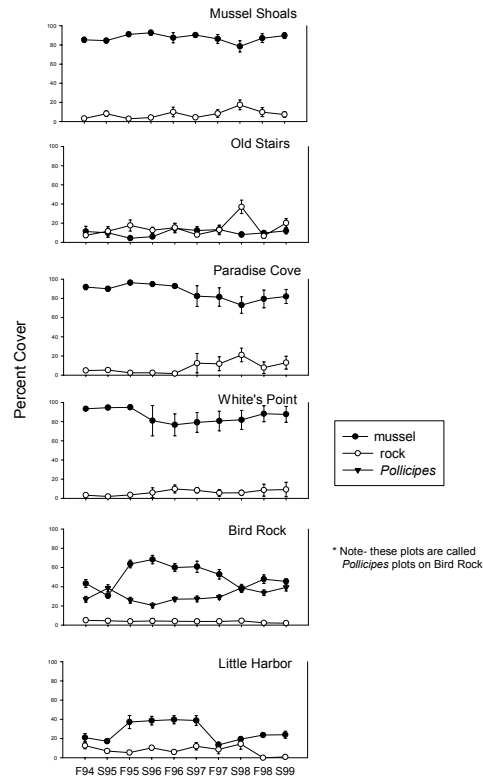


Figure 2. Trends in *Mytilus* cover at all sites monitored.

* Note- these plots are called *Pollicipes* plots on Bird Rock

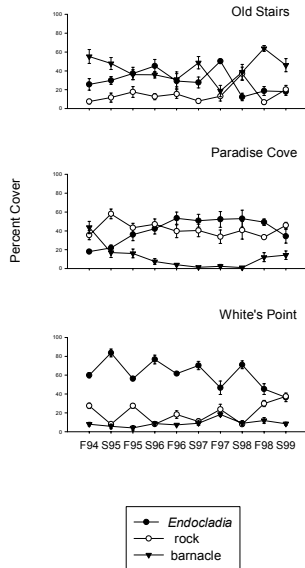


Figure 3. Trends in *Endocladia* cover at all sites monitored.

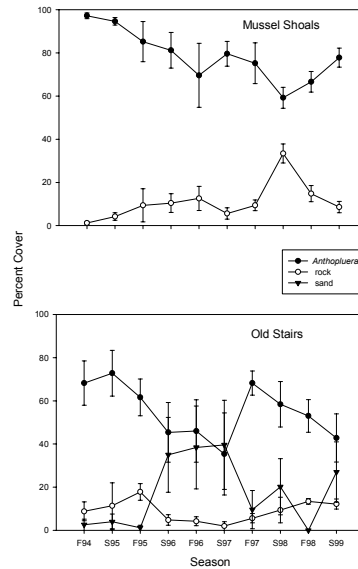


Figure 4. Percent cover of *Anthopleura* at two Ventura County sites.

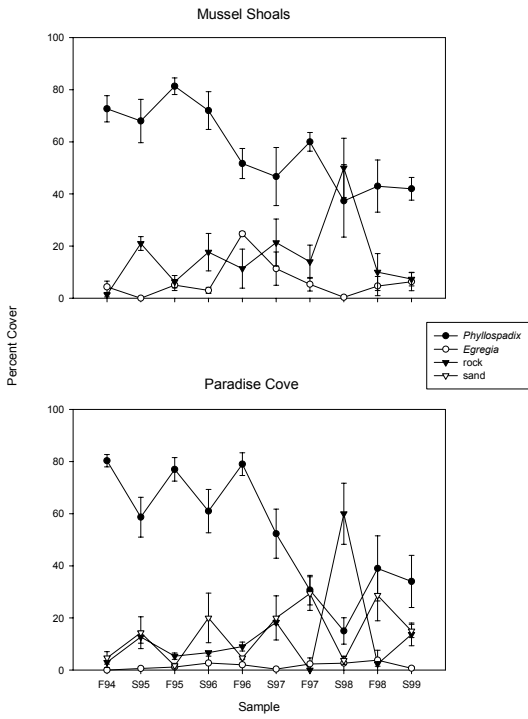


Figure 5. *Phyllospadix* cover from transects at two sites.

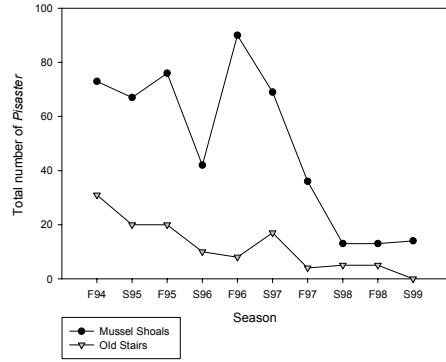


Figure 6. Total number of *Pisaster* within monitored plots at two sites in Ventura County.

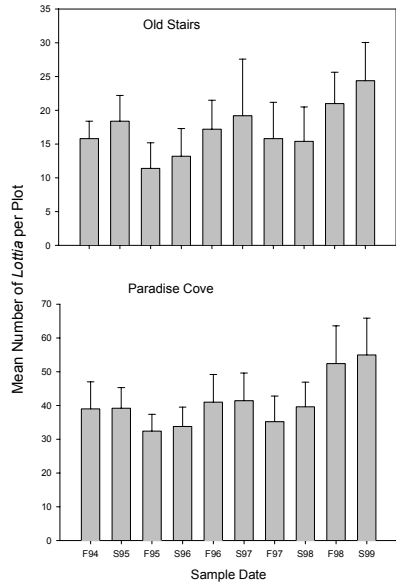


Figure 7. *Lottia* abundance at two sites in Ventura and LA counties.

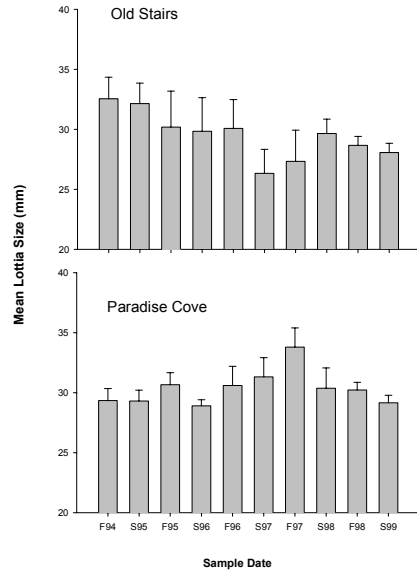


Figure 8. *Lottia* mean sizes at two sites in Ventura and LA counties.

Inventory of Rocky Intertidal Resources in Orange County

Principal Investigator: Dr. Steven N. Murray (Dept. of Biological Science, California State University, Fullerton, CA 92834)

Project Summary:

During the past year, two new people joined the project. Everett Yee entered in the fall and Amanda Gerrard began work in February. Both of the new researchers are graduate students of Steven Murray at CSU Fullerton.

Several changes in abundances of intertidal populations have been observed during the recent sampling periods. Over the past year, we have observed an increase in the abundance of *Pisaster ochraceous* at all four sites (Table 2). We have also observed large increases in the percent cover of the brown alga *Egregia mensezii* especially in seagrass transects at Crystal Cove (Figure 5).

During the 1997-98 sampling periods, we observed a large decrease in the abundance of mussels (*Mytilus californianus*). This disturbance, probably due to increased wave activity associated with the 1997-98 ENSO, opened gaps in the mussel beds where we have recently observed a large recruitment of the bay mussel *Mytilus galloprovincialis*. The recruitment of the bay mussel was prominent at all four sites. In addition, we have noticed an increase in the abundance of fleshy red algae which may also be associated with the opening of space in the low intertidal.

Finally, we have noted that the number of striped shore crabs (*Pachygrapsus crassipes*) seemed to be in much lower abundance than in previous years and over the past decade. This may have occurred over several years, but was just noticed over the last year.

Table 1. Sampling schedule for Fall 1998 and Spring 1999 in Orange County.

| Location | Date | Researchers | Comments |
|-----------------|---------------------|--|-------------------|
| Crystal Cove | 12/5/98 4/25/99 | S. Murray, J. Smith, J. Kido, J. Koehnke, E. Yee, A. Gerrard | Some repairs made |
| Dana Point | 11/7/98 4/23/99 | S. Murray, J. Smith, J. Kido, J. Koehnke, E. Yee, A. Gerrard | Some repairs made |
| Shaw's Cove | 12/6/98 4/23/99 | S. Murray, J. Smith, J. Kido, J. Koehnke, E. Yee, A. Gerrard | Some repairs made |
| Treasure Island | 12/18/98 4/16/99 | S. Murray, J. Smith, J. Kido, J. Koehnke, E. Yee, A. Gerrard | Some repairs made |

Future Plans:

Future plans include archiving photographs by digitizing photoplot images and storing them on compact disks. We will also continue to examine the possibility of improving our mapping ability with other resources including GPS and above site photography (i.e. from a helicopter). In addition, we will continue to examine the video versus still images question for

obtaining meaningful data on distributions and abundances of populations outside of our photoplots.

Problems Encountered:

Problems encountered have been minimal. All sites needed some repairs including replacement of marker bolts and general improvements to maps. Questions also arose during field sampling of *Phyllospadix* transects on which organism to count when layering of the seagrass and *Egrecia* occurred. This has never been a problem until this year when *Egrecia* populations increased.

Data Summary For Orange County:

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. Barnacle cover has remained relatively stable during the three year sampling period except during the Fall 1998 sampling period, where we observed sharp decreases in barnacle cover (approx. 20%) at all four sites. This was then followed by slight increases in cover (approx. 5%) during the Spring 1999 sampling period.

Figure 2. *Endocladia* cover at Shaw's Cove has remained relatively stable throughout the three year sampling period. Cover decreased slightly in Fall of 1998 to approximately 22% where it remained through Spring 1999.

Figure 3. *Pelvetia compressa* cover has decreased steadily at all four sites since the first sampling period in Fall 1996. The largest decreases in cover were seen in Fall 1998. Cover remained stable in Spring 1999 but is approximately 40% less than the cover observed in Fall 1996.

Figure 4. We observed slight decreases in mussel cover (approx. 10%) at all sites during the Fall 1998 sampling period. This decrease was not as severe as decreases seen during the Spring 1998 sampling period that had mussel cover losses of about 35% because of increased wave activity associated with the 1997-98 ENSO. The Spring 1999 sampling period yielded little change in cover from the Fall 1998 period except for Crystal Cove which had an increase in cover. This may be due to two mussel plots that were completely cleared of mussels in Spring 1998 but are now near 90% cover of new *Mytilus galloprovincialis* recruits.

Phyllospadix Transects:

Figure 5. At Crystal Cove, *Phyllospadix* cover has decreased steadily from approximately 90% to 50% since the initial sampling except some slight increases in the fall sampling periods. During the Fall 1998 and Spring 1999 sampling periods, we observed an increase in *Egrecia* cover.

Pisaster Plots:

Table 2. As of the spring 1999 sampling period, the number of *Pisaster* has increased at all four sites. The biggest increases in number of *Pisaster* were found at Crystal Cove, Shaw's Cove, and Treasure Island. At these three sites, the number of *Pisaster* has increased approximately three to six times relative to the spring and fall 1998 sampling periods. At Dana Point the number of *Pisaster* doubled from fall 1998 and increased four times from spring 1998, although only 1 individual was found in spring 1998.

Abalone Counts

Table 3. As of Spring 1999, no abalone has yet to be found at any of the four sampling sites

Lottia Plots:

Figure 6. *Lottia gigantea* abundance has remained relatively stable at two of the three *Lottia* sampling sites in Orange County (Treasure Island is not sampled). At Shaw's Cove, we observed an increase in Owl limpet abundance in Spring 1998 and a slight decrease since then. Shaw's Cove, which has two to three times the abundance of *Lottia* than the other two sampling sites, has had its abundance double since the first sampling period in Fall 1996.

Figure 7. Mean *Lottia gigantea* size has remained relatively stable at all three sampling sites.

Table 2. Summary of data obtained for sea stars (*Pisaster* spp.) based on searches performed at the four Orange County sites. Data were not taken during Fall 1996:

n/a = data unavailable.

| Site | Fall 1996 | Spring 1997 | Fall 1997 | Spring 1998 | Fall 1998 | Spring 1999 |
|-----------------|-----------|-------------|-----------|-------------|-----------|-------------|
| Crystal Cove | n/a | 13 | 7 | 2 | 6 | 42 |
| Shaw's Cove | n/a | 3 | 1 | 13 | 7 | 39 |
| Treasure Island | n/a | 2 | 0 | 5 | 1 | 14 |
| Dana Point | n/a | 1 | 0 | 1 | 2 | 4 |

Table 3. Summary of data obtained for abalone (*Haliotis* spp.) based on searches performed at the four Orange County sites. Data were not taken during Fall 1996:

n/a = data unavailable.

| Site | Fall 1996 | Spring 1997 | Fall 1997 | Spring 1998 | Fall 1998 | Spring 1999 |
|-----------------|-----------|-------------|-----------|-------------|-----------|-------------|
| Crystal Cove | n/a | 0 | 0 | 0 | 0 | 0 |
| Shaw's Cove | n/a | 0 | 0 | 0 | 0 | 0 |
| Treasure Island | n/a | 0 | 0 | 0 | 0 | 0 |
| Dana Point | n/a | 0 | 0 | 0 | 0 | 0 |

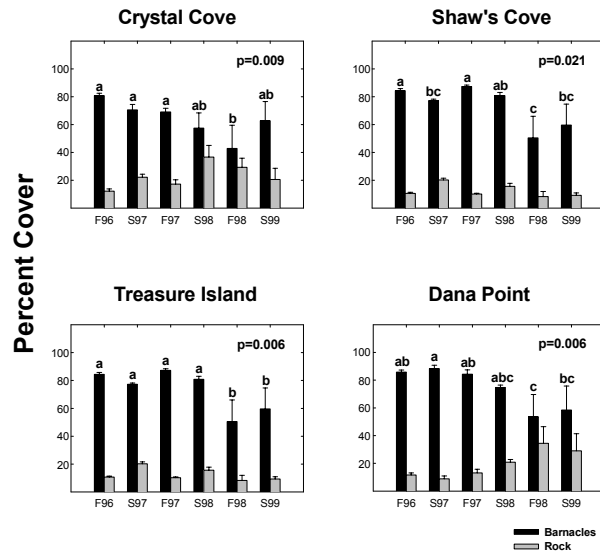


Figure 1. Mean cover of barnacles (*Chthamalus* spp. and *Balanus glandula*) and unoccupied rock as a function of sampling period for the fixed photoplots at the four study sites. Statistical analyses performed only on barnacle data. Probability values are for repeated measures ANOVA for all sites except Shaw's Cove where, because of variance heterogeneity, Friedman's Randomized Block non-parametric test procedure was required. Mean values followed by the same letter belong to the same subset Student-Newman-Keuls (SNK) *a-posteriori* multiple comparison test.

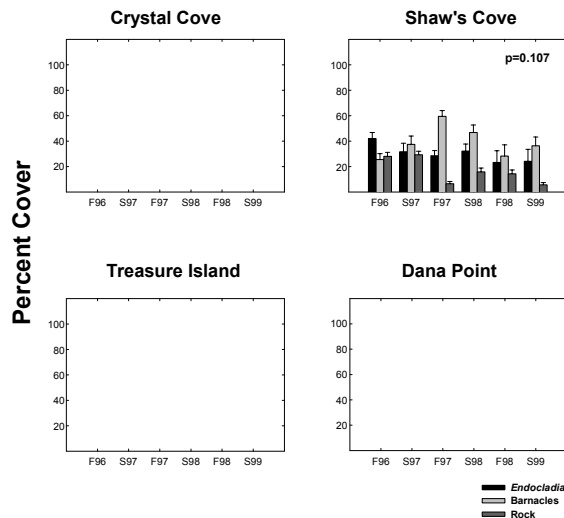


Figure 2. Mean cover of turf weed (*Endocladia muricata*), barnacles (*Chthamalus* spp. and *Balanus glandula*) and unoccupied rock as a function of sampling period for the fixed photoplots at Shaw's Cove. *Endocladia muricata* was not sampled at the other three study sites. Statistical analyses performed only on turf weed data. Probability values are for repeated measures ANOVA.

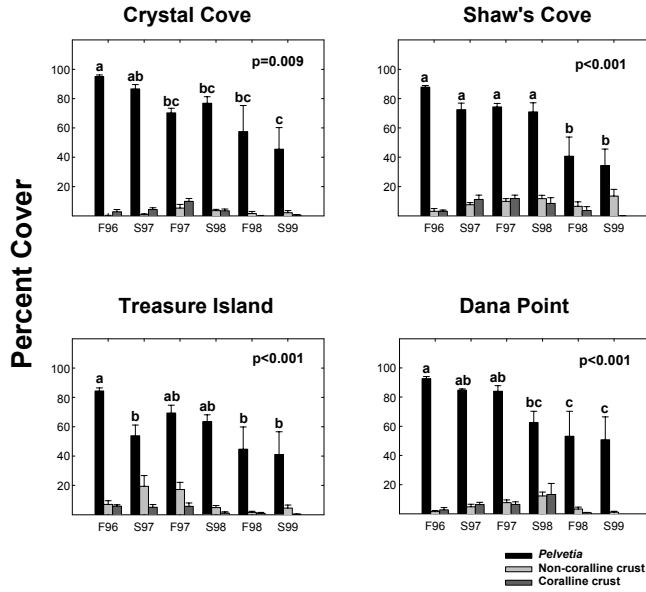


Figure 3. Mean cover of rockweed (*Pelvetia compressa*), coralline crusts, and non-coralline crusts (mostly *Pseudolithoderma nigra*) as a function of sampling period for the fixed photoplots at the four study sites. Statistical analyses performed only on rockweed data. Probability values are for repeated measures ANOVA for all sites except Crystal Cove where, because of variance heterogeneity, Friedman's Randomized Block non-parametric test procedure was required. Mean values followed by the same letter belong to the same subset Student-Newman-Keuls (SNK) *a-posteriori* multiple comparison test.

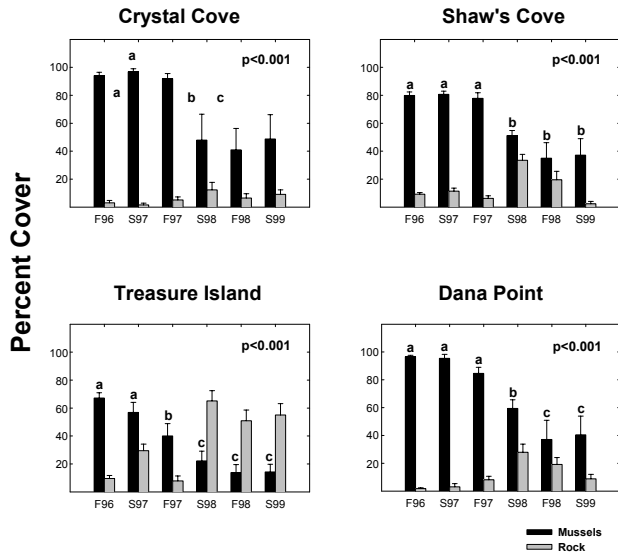


Figure 4. Mean cover of mussels (essentially *Mytilus californianus*) and unoccupied rock as a function of sampling period for the fixed photoplots at the four study sites. Statistical analyses performed only on mussel data. Probability values are for repeated measures ANOVA for all sites except Crystal Cove where, because of variance heterogeneity, Friedman's Randomized Block non-parametric test procedure was required. Mean values followed by the same letter belong to the same subset Student-Newman-Keuls (SNK) *a-posteriori* multiple comparison test.

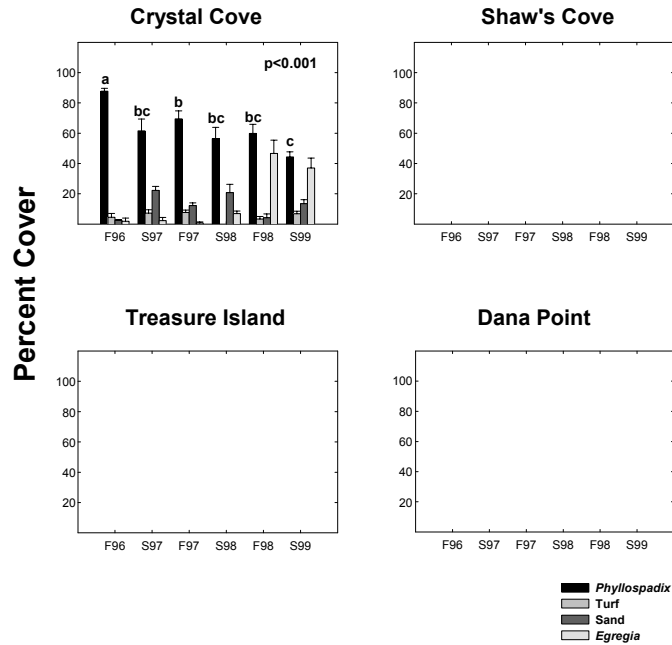


Figure 5. Mean cover of surf grass (*Phyllospadix* spp.), algal turf (mostly *Gelidium* spp. and *Corallina* spp.), feather boa kelp (*Egregia menziesii*), and sand as a function of sampling period for the fixed photoplots at Crystal Cove. *Phyllospadix* was not measured at the other three study sites. Statistical analyses performed only on surf grass data. Probability values are for repeated measures ANOVA. Mean values followed by the same letter belong to the same subset Student-Newman-Keuls (SNK) *a-posteriori* multiple comparison test.

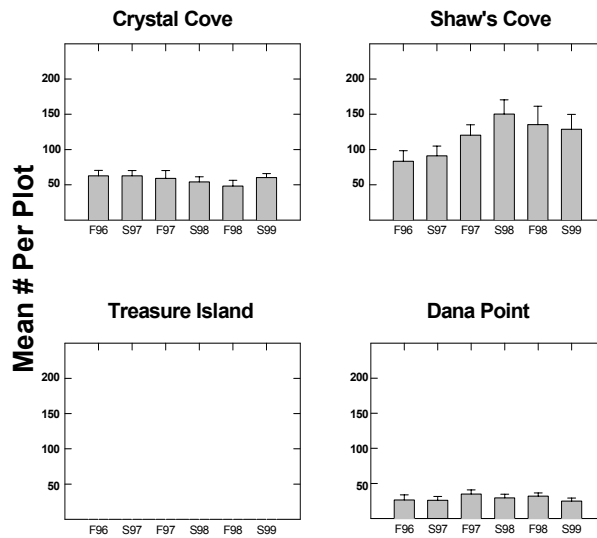


Figure 6. Mean number of owl limpets (*Lottia gigantea*) per fixed circular plots (3.14m²) as a function of sampling period for three of the four study sites. *Lottia gigantea* was not sampled at Treasure Island.

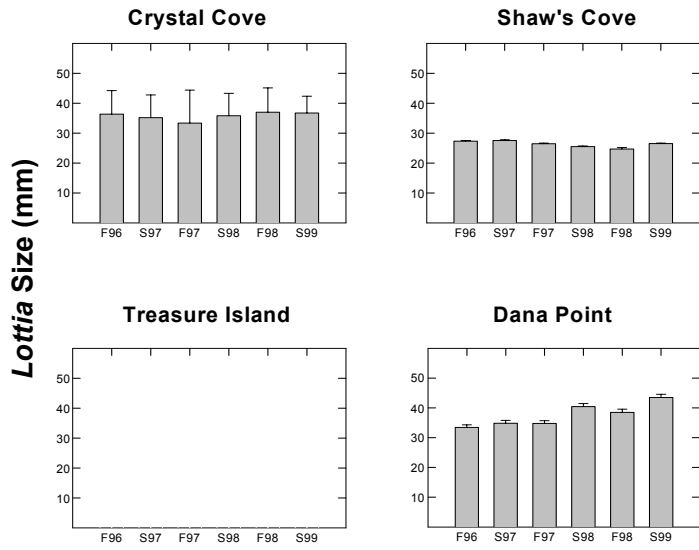


Figure 7. Mean size (mm) of owl limpets (*Lottia gigantea*) per fixed circular plots (3.14m²) as a function of sampling period for three of the four study sites. *Lottia gigantea* was not sampled at Treasure Island.

RESEARCH PRODUCTIVITY

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FINAL REPORTS

- Spatial Scale of Produced Water Impacts as Indicated by Plume Dynamics. OCS Study MMS 96-0001. By S. MacIntyre and L. Washburn.
- Characterization of Organic Constituent Patterns at a Produced Water Discharge Site/Barium Relations to Bioeffects of Produced Water. OCS Study MMS 97-0022. By R.M. Higashi, A.D. Jones and T. W-M. Fan.
- Identification of Bioactive Compounds from Produced Water Discharge/Characterization of Organic Constituent Patterns at a Produced Water Discharge Site. OCS Study MMS 97-0023. By R.M. Higashi and A.D. Jones.
- How Political Activists See Offshore Oil Development: An In-depth Investigation of Attitudes on Energy Development. OCS Study MMS 98-0042. By Eric R.A.N. Smith.

Environmental Degradation and Identification of Toxic Compounds of Petroleum and Associated Materials. OCS Study MMS 99-0017. By R. Higashi and D. Crosby.

Raimondi P.T., R.F. Ambrose, J.M. Engle, S.N. Murray, M. Wilson. 1999. Monitoring of Rocky Intertidal Resources along the Central and Southern California Mainland. 3-Year Report for San Luis Obispo, Santa Barbara, and Orange Counties (Fall 1995-Spring 1998). OCS Study MMS 99-0032.

Raimondi P.T. 1999 Assessment of Impacts to Rocky Intertidal Biota: Torch/Platform Irene Pipeline Oil Spill, September 1997, Santa Barbara County, CA.

IN PRESS

Raimondi PT and S Forde. Processes structuring communities: evidence for trait mediated interactions through induced polymorphisms. *Ecology*.

Sorlien. C. C., Kamerling, M. J., and Mayerson, D. 1999. Block rotation and termination of the Hosgri strike-slip fault, California, from three-dimensional map restoration, *Geology*. v. 27, no. 11.

Flegal, AR, I Rivera-Duarte, and S Sañudo-Wilhelmy. Silver contamination in aquatic environments. *Review in Environmental Chemistry and Toxicology*.

Reed DC, MH Carr, L Goldwasser and PT Raimondi. Role of dispersal potential in determining the spatial structure of an assemblage of sedentary marine organisms. *Ecology*.

Seeber, L and CC Sorlien. Listric thrust in the western Transverse Ranges, California. *Geological Society of America Bulletin*.

Smith, ERAN and SR Garcia. Evolving California opinion on offshore oil development. *Ocean and Coastal Management*.



PERSONNEL FUNDED



**PERSONNEL FUNDED BY THE
SOUTHERN CALIFORNIA EDUCATIONAL INITIATIVE IN 1998-1999**

| Name | Status | Supervisor |
|-----------------------|---------------------------|-------------------|
| Snyder, Mark | Asst. Research Biochemist | Cherr |
| Altstatt, Jessica | Graduate | Ambrose |
| Anghera, Michelle | Graduate | Ambrose |
| Hamdoun, Amro | Graduate | Cherr |
| Wilson, Jacqueline | Graduate | Osenberg |
| Forde, Samantha | Graduate | Raimondi |
| Sabin, Paul | Graduate | Schurman |
| Herms, William | Graduate | Smith |
| Craig, Cory | Graduate | Stewart-Oaten |
| Valeva, Anna | Graduate | Stewart-Oaten |
| Vines, Carol | Graduate/Post Doctoral | Cherr |
| Anghera, Michele | Post Graduate | Reed |
| Hibbard-Robbins, Thea | Post Graduate | Griffin |
| Machula, Jana | Post Graduate | Griffin |
| Lee, Steven | Staff Research Assistant | Ambrose |
| Wilson, Melissa | Staff Research Associate | Raimondi |
| Smith, Derek | Technical Assistant | Raimondi |
| Francis, L. | Undergraduate | Ambrose |
| Countermain, Brian | Undergraduate | Bush |
| Graziani, Brian | Undergraduate | Bush |
| Aragon, Leah | Undergraduate | Cherr |
| Kwong, Lina | Undergraduate | Cherr |
| Francioch, Chris | Undergraduate | Carr |
| Stier, Jeanine | Undergraduate | Carr |
| Berman, Dan | Undergraduate | Carr |
| Hansen, Dan | Undergraduate | Carr |
| Hamera, Trisha | Undergraduate | Carr |
| Shinen, Jenna | Undergraduate | Carr |
| Forbes, Melanie | Undergraduate | Carr |
| Clark, Sara | Undergraduate | Carr |
| Wood-Charlson, Elisha | Undergraduate | Carr |
| O'Connor, Brendan | Undergraduate | Carr |
| Bailey, Dawn | Undergraduate | Raimondi |
| Owings, Sally | Undergraduate | Raimondi |

Southern California Educational Initiative

Yonehiro, Jason
Miyagishima, Juliet

Undergraduate
Undergraduate

Raimondi
Smith

Follow-up on previous trainees

Kristin Zabaronick (UCSB) has begun graduate school in environmental sciences at the University of Colorado.

Bryn Evans (UCSB) is finishing a master's degree in marine ecology at the University of California, Los Angeles.

Chris Francioch, Jeanine Stier and Dan Berman (UCSC undergraduates) were involved in the size frequency analyses in Carr's lab and have all graduated from UCSC.

Dan Hansen (UCSC graduate), who assisted in Carr's lab, is starting graduate studies at UC Davis.

Jacqueline Wilson (UF, PhD student) has been involved in database management and analyses in Osenberg's lab at UF. She completed her Master's degree (at UF in Osenberg's lab in 1998) and is now continuing with her Ph.D. research.

CURRICULUM VITAE

Richard Ambrose
Douglas Bush
Mark H. Carr
Gary N. Cherr
Jenifer Dugan
Linda Fernandez
Fred J. Griffin
Scott Hodges
Sally H. Holbrook
Michael V. McGinnis
Steve N. Murray
Roger Nisbet
Craig W. Osenberg
H. Mark Page
Carolyn Pomeroy
Peter T. Raimondi
Daniel C. Reed
Paul Sabin
Russell J. Schmitt
Stephen Schroeter
Rachel A. Schurman
Eric R.A.N. Smith
Allan Stewart-Oaten

RICHARD AMBROSE

Environmental Science and Engineering Program
Department of Environmental Health Sciences
University of California
Los Angeles, CA

Project: *Evaluating the Impact of Oil Spills on Southern California Rocky Intertidal Populations and Communities: Development of a Handbook*

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

Positions:

1992-present Associate Professor, Environmental Science and Engineering Program,
Department of Environmental Health Sciences, University of California, Los Angeles
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:

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.

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.

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

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

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.
- 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.
- Alltstatt, J.A., R.F. Ambrose, J.M. Engle, P.L. Haaker, K.D. Lafferty, 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.
- Ambrose, R.F., R.J. Schmitt, and C. W. Osenberg. 1996. Predicted and Observed Environmental Impacts: Can We Foretell Ecological Change. Pp. 343-367 in: *Detecting Ecological Impacts: Concepts and Applications in Coastal Habitats*, R.J. Schmitt and C.W. Osenberg, eds. Academic Press, San Diego, CA.
- Ambrose, R.F. 1995. Performance standards for coastal wetland restoration. Pp. 395-397 in: *Proceedings of the National Interagency Workshop on Wetlands: Technology Advances for Wetlands Sciences*, M.C. Landin, ed. Technical Report, Wetlands Research and Technology Center, US Army Engineers Waterways Experiment Station, Vicksburg, Mississippi.
- Ambrose, R.F., J. Boland, W.W. Murdoch, P.T. Raimondi, and D. Reed. 1995. The San Onofre Nuclear Generating Station mitigation reef: monitoring issues. Proceedings of Ecoset '95, the International Conference on Ecological System Enhancement Technology for Aquatic Environments, pp. 587-592.
- Ambrose, R.F., J.M. Engle, P.T. Raimondi, M. Wilson and J.A. Altstatt. 1995. Rocky intertidal and subtidal resources: Santa Barbara County mainland. Final report to the Minerals Management Service. OCS Study MMS 95-0067.
- Ambrose, R.F. 1994. Mitigating the effects of a coastal plant on a kelp forest community: rationale and requirements for an artificial reef. *Bulletin of Marine Science* **55**:694-708.
- DeMartini, E.E., A.M. Barnett, T.D. Johnson, and R.F. Ambrose. 1994. Growth and production estimates for biomass-dominant fishes on a southern California artificial reef. *Bulletin of Marine Science* **55**:484-500.
- Holbrook, S.J., S.L. Swarbrick, R.J. Schmitt, and R.F. Ambrose. 1994. Reef architecture and reef fish: correlates of population densities with attributes of subtidal rocky environments. Pp. 99-106 in: *Proceedings of the Second International Temperate Reef Symposium*, C.M. Battershill *et al.* eds. NIWA Marine, Wellington.
- Johnson, T.D., A.M. Barnett, E.E. DeMartini, L.L. Craft, R.F. Ambrose, and L.J. Purcell. 1994. Fish utilization of a southern California artificial reef. *Bulletin of Marine Science* **55**:709-713.
- Ambrose, R.F., J.A. Coyer, J.M. Engle, and B.V. Nelson. 1993. Changes in urchin and kelp densities at Anacapa Island, California. Pp. 199-209 in: *Third California Islands Symposium: Recent Advances in Research on the California Islands*, F.G. Hochberg, ed. Santa Barbara Museum of Natural History, CA.
- Coyer, J.A., R.F. Ambrose, J.M. Engle, and J.C. Carroll. 1993. Interactions between corals and algae on a temperate zone rocky reef: mediation by sea urchins. *Journal of Experimental Marine Biology and Ecology* **167**:21-37.
- Bonsack, J.A., D.L. Johnson, and R.F. Ambrose. 1991. Ecology of artificial reef habitats and fishes. Pp. 61-107 in: *Artificial Habitats for Marine and Freshwater Fisheries*, W. Seaman, Jr. and L.M. Sprague, eds. Academic Press, San Diego, CA.

DOUGLAS BUSH

Marine Science Institute
University of California
Santa Barbara, CA

Project: *Application of Genetic Techniques for use in Restoration of Surfgrass, Phyllospadix torreyi*

Education: B.A. Botany, University of Hawaii 1974
M.S. Plant Physiology, UC Berkeley 1979
Ph.D. Plant Physiology, UC Berkeley 1983
Postdoctoral Botany, UC Berkeley 1984 – 1989

Positions: 1998-Present Associate Research Biologist, Marine Science Institute, UC Santa Barbara
1998-Present Adjunct Associate Professor, Dept. Ecology, Evolution, & Marine Biology, UC Santa Barbara
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 Interest:

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 MT and DS Bush. 1999. Gibberellin-induced cell death in the wheat aleurone. *Plant Physiology*. (submitted).
- Subbaiah C, DS Bush, and M Sachs. 1998. Mitochondria contribution to the anoxic Ca²⁺ signal in maize suspension-cultured cells. *Plant Physiology* **118**: 759-771.
- Silverman P, A Assiahmah, and DS Bush. 1997. Cytokinin action in root hairs of *Medicago sativa*. *Planta* **205**: 25-31.
- Kuo A, S Cappellutti, M Cervantes-Cervantes, M Rodriguez, and DS 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.
- Bush DS. 1996. Effects of gibberellic acid and environmental factors on cytosolic calcium in wheat aleurone cells. *Planta*. **199**:89-99.
- Bush DS. 1995. Calcium regulation in plant cells and its role in signaling. *Annu. Rev. Plant Physiology. Plant Molecular Biology* **46**:95-122.
- Bush DS and T Wang. 1995. Diversity of calcium efflux transporters in wheat aleurone cells. *Planta*. **197**:19-30.
- Subbaiah C, DS Bush, and M Sachs. 1994. Elevation of cytosolic calcium precedes anoxic gene expression in maize suspension-cultured cells. *The Plant Cell* **6**:1747-1762.
- Bush DS. 1993. Regulation of cytosolic calcium in plants. *Plant Physiology* **103**:7-13.
- Bush DS, AK Biswas, and RL Jones. 1993. Hormonal regulation of Ca²⁺-transport in the endomembrane system of the barley aleurone. *Planta* **189**:507-515.

- Bush DS. 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 BK, DS Bush, RL Jones, AP Dawson, and IB Ferguson. 1992. Analysis of calcium involvement in host-pathogen interactions. In: Gurr, SJ, MJ McPherson, and DJ Bowles eds. "Molecular Plant Pathology: A Practical Approach". Vol. II, pp. 159-194. IRL Press at Oxford University Press, Cambridge.
- Jones RL, L Sticher and DS 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.
- Arnalte ME, MJ Cornejo, DS Bush, and RL Jones. 1991. The effect of gibberellic acid on the lipid composition of barley aleurone protoplasts. *Plant Science* **77**:223-232.
- Bush DS, L Sticher, and RL 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 RL and DS Bush. 1991. Gibberellic acid and abscisic acid regulate the level of a BiP cognate in the endoplasmic reticulum of barley aleurone cells. *Plant Physiology* **97**: 456-459.
- Bush DS and RL 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.
- Bush DS and RL 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.
- DuPont FM, DS Bush, JJ Windle, and RL Jones. 1990. Calcium and proton transport in membrane vesicles from barley roots. *Plant Physiol.* **94**:179-188.
- Sticher L, AK Biswas, DS Bush, and RL 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.
- Hillmer S, DS Bush, DG Robinson, I Zingen-Sell, and RL Jones. 1990. Endomembrane structure and function in barley aleurone protoplasts. *Eur. J. Cell Biol.* **52**:169-173.
- Jones RL and DS Bush. 1990. Regulation of calcium flux and steady state levels by plant growth regulators. In: D. Randall, ed. "Current Topics in Plant Biochemistry and Physiology". V. 9, pp. 10-19.
- Bush DS, AK Biswas, and RL Jones. 1989. Gibberellic-acid-stimulated Ca^{2+} accumulation in endoplasmic reticulum of barley aleurone: Ca^{2+} transport and steady-state levels. *Planta.* **178**:411-420.
- Bush DS, AK Biswas, and RL Jones. 1989. Calcium transport into the endoplasmic reticulum of barley aleurone is regulated by gibberellic acid. In: Dainty I, MI DeMichelis, E Marre, and F Rasi-Caldogno, eds. "Plant Membrane Transport: The Current Position". Elsevier, Amsterdam. pp. 237-242.
- Bush DS L Sticher, RV Huystee, D Wagner, and RL Jones. 1989. The calcium requirement for stability and enzymatic activity of two isoforms of barley aleurone α -amylase. *J Biol. Chem.* **264**:19392-19398.
- Sticher L, Bush DS, AK Biswas, and RL Jones. 1989. Heat shock inhibits α -amylase synthesis in barley aleurone without inhibiting the activity of endoplasmic reticulum marker enzymes. *Plant Physiol.* **88**:1168-1174.
- Bush DS, R Hedrich, J Schroeder, and R Jones. 1988. Channel-mediated K^{+} -flux in barley aleurone protoplasts. *Planta.* **176**:368-377.
- Bush DS, RL Jones, and AK Biswas. 1988 Measurement of cytoplasmic Ca^{2+} and H^{+} in barley aleurone protoplasts. *Plant Cell Tiss. Organ. Culture* **12**:159-162.
- Jacobsen JV, DS Bush, L Sticher, and RL Jones. 1988. Evidence for precursor forms of the low-pI α -amylase isozymes secreted by barley aleurone cells. *Plant Physiol.* **88**:1168-1174.
- Jones RL, DS Bush, and AK Biswas. 1987. Gibberellic acid and calcium participate in the synthesis of active α -amylase molecules. In: "British Plant Growth Regulator Group, Monograph". **15**:31-42.

Jones RL, DS Bush, L Sticher, P Simon, and JV Jacobsen. 1987. Intracellular transport and secretion of barley aleurone α -amylase. In: Leaver C, and H Sze, eds. "Plant Membranes: structure, function biogenesis". Alan R. Liss, New York. pp. 325-340.

MARK H. CARR

Department of Biology
University of California
Santa Cruz, CA

Projects: *Detecting Ecological Impacts: Effects of Taxonomic Aggregation in the Before-After/Control-Impact Paired Series Design*

| | | | |
|------------------|-------|---|------|
| 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 MH, and PT Raimondi. 1999. Marine protected areas as a precautionary approach to management. CALCOFI reports.

Reed DC, MH Carr, L Goldwasser and PT Raimondi. Role of dispersal potential in determining the spatial structure of an assemblage of sedentary marine organisms. *Ecology*.

Reed, D.C., P.T. Raimondi and M.H. Carr. Role of dispersal potential in determining spatial variability in the abundance of benthic reef organisms. *Ecology*. Submitted.

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.

Allison, G., J. Lubchenco, and M.H. Carr. 1998. Marine reserves are necessary but not sufficient for marine conservation. *Ecological Applications* **8(1)**:Supplement S79-S92.

Hixon, M.A., M.H. Carr, and J.P. Beets. Artificial reefs: importance of comparisons with natural reefs. In: W. Seaman, ed., *Future Artificial Reefs in the U.S. Coastal Ocean: Can Science Resolve the Biological Enhancement Question?* Atlantic States Marine Fisheries Commission, Washington D.C. Special Report XX.

Hixon, M.A. and M.H. Carr. 1997. Synergistic predation causes density-dependent mortality in marine fish. *Science* **277**:946-949.

- Carr, M.H. and M.A. Hixon. 1997. Artificial reefs: the importance of comparisons with natural reefs. *Fisheries* **22**:28-33.
- Caley, M.J. M.H. Carr, M.A. Hixon, T.P. Hughes, G.P. Jones, and B.A. Menge. 1996. 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. 1995. Predation effects on early survivorship of coral reef fishes. *Marine Ecology Progress Series* **124**:31-42.
- Carr, M.H. 1994. Effects of macroalgal dynamics on recruitment of a temperate reef fish. *Ecology* **75**:1320-1333.
- Carr, M.H. 1994. Predicting the recruitment of temperate reef fishes in response to changes in macrophyte density caused by disturbance. Pp. 255-269 in: *Theory and Application of Fish Feeding Ecology*, D.J. Stouder, K.L. Fresh and R.J. Feller, eds. The Belle W. Baruch Library in Marine Science Number 18, University of South Carolina Press, Columbia, SC.
- Carr, M.H. and D.C. Reed. 1993. Conceptual issues relevant to marine harvest refuges: examples from temperate reef fishes. *Canadian Journal of Aquatic Sciences and Fisheries* **50**:2019-2028.
- Love, M.S., M.H. Carr, and L.J. Haldorson. 1991. The ecology of substrate-associated juveniles of the genus *Sebastes*. *Environmental Biology of Fishes* **30**:225-243.
- Carr, M.H. 1991. *Patterns, mechanisms and consequences of recruitment of a temperate marine reef fish*. Doctoral Dissertation, University of California, Santa Barbara, California, 190p. NOAA Sea Grant publication, University of Southern California Sea Grant Program.
- Carr, M.H. 1991. Habitat selection and recruitment of an assemblage of temperate zone reef fishes. *Journal of Experimental Marine Biology and Ecology* **146**:113-137.
- Carr, M.H. 1989. Effects of macroalgal assemblages on the recruitment of temperate zone reef fishes. *Journal of Experimental Marine Biology and Ecology* **126**:59-76.
- Holbrook, S.J., M.H. Carr, R.J. Schmitt, and J.A. Coyer. 1989. The effect of giant kelp on local abundance of reef fishes: the importance of ontogenetic resource requirements. *Bulletin of Marine Science* **41**:104-114.

GARY N. CHERR

University of California, Davis
Bodega Marine Laboratory
Bodega Bay, CA

- Project:** *Effects of Biologically Degraded Oil on Marine Invertebrate and Vertebrate Embryos and Larvae*
- Education:** B.A. Biology, Sonoma State University 1979
Ph.D. Zoology, University of California, Davis 1984
- Positions:** 1995-present Lecturer, Division of Biological Sciences, University of California, Davis
1995-present Adjunct Associate Professor, Sonoma State University
1994-present Associate Research Biologist III, Bodega Marine Laboratory, University of California, Davis
1990-1994 Assistant Research Biologist IV, Bodega Marine Laboratory, University of California, Davis
1988-90 Assistant Research Biologist III, Bodega Marine Laboratory, University of California, Davis
1986-88 Assistant Research Biologist II, Bodega Marine Laboratory, University of California, Davis
1984-86 Postdoctoral Fellow, National Institute of Health, Department of Obstetrics & Gynecology, School of Medicine, University of California, Davis
- Distinctions:** 1984 National Institute of Health Postdoctoral Fellowship, Reproductive Training Grant
1983 Best Student Paper Award, Annual American Fisheries Society Meeting

Research Interests:

Dr. Cherr's laboratory investigates cell functioning during fertilization and early development in marine and estuarine organisms, and the effects of pollutants and environmental stressors. The systems utilized in the laboratory include gametes and embryos from algae, molluscs, echinoderms, and fishes. Since these systems exhibit temporally and mechanistically distinct cellular events during development, they can be used to discern the mode of action of pollutants at the subcellular levels. A major emphasis is placed on the effects of pollutants on cytoskeletal dynamics, intracellular ion activities, and cell-extracellular matrix interactions during fertilization and development. The laboratory is also involved in isolation and identification of pollutants in complex mixtures and investigates structure/function relationships of the pollutants using the above biological systems. Dr. Cherr is Chair of the State of Washington Biomonitoring Science Advisory Board, and is on the State of California's Marine Bioassay Protocol Review Committee.

Selected Publications:

- Yudin, A.I., G.N. Cherr, C.A. VandeVoort, and J.W. Overstreet. 1998. Rearrangement of the PH-20 protein on the surface of macaque spermatozoa following exposure to anti-PH-20 antibodies or binding to zona. *Molecular Reproduction and Development* **50**:207-220.
- Clegg, J.S., K.R. Uhlinger, S.A. Jackson, G.N. Cherr, E. Rifkin, and C.S. Friedman. 1998. Induced thermotolerance and the heat shock protein-70 family in the Pacific oyster, *Crassostrea gigas*. *Molecular Marine Biology and Biotechnology* **7**:21-30.
- Griffin F.J., M.C. Pillai, C.A. Vines, R. Yanagimachi, and G.N. Cherr. 1998. Effects of salinity on sperm motility, fertilization, and development in the Pacific herring, *Clupea pallasii*. *Biological Bulletin* **194**:25-35.

- Middaugh, D.P., M.W. Shelton, C.L. McKenney Jr., G.N. Cherr, P.J. Chapman, and L.A. Courtney. 1998. Preliminary observations on responses of embryonic and larval Pacific herring, *Clupea pallasii*, to neutral fraction biodegradation products of weathered Alaska North Slope Oil. *Archives Environmental Contamination and Toxicology* **34**:188-196.
- Cherr, G.N. 1998. The use of developing organisms for assessing contamination in the marine environment. In: *Effects of Multiple Impacts on Ecosystems*, J.J. Cech, B.W. Wilson and D.C. Crosby, eds. Lewis Publishers, Chelsea, MI.
- Shamseldin, A.A., J.S. Clegg, C.S. Friedman, G.N. Cherr, and M.C. Pillai. 1997. Induced thermotolerance in the Pacific oyster, *Crassostrea gigas*. *Journal of Shellfish Research*, **16**:487-491.
- Garman, G.D., G.N. Cherr, and S.L. Anderson. 1997. Developmental abnormalities and DNA-protein crosslink induction in sea urchin embryos exposed to metals. *Aquatic Toxicology* **39**:247-265.
- Meyers, A.S., A.I. Yudin, G.N. Cherr, C.A. Vandevort, D.G. Myles, P. Primakoff, and J.W. Overstreet. 1997. Hyaluronidase activity of macaque sperm assessed by an *in vitro* cumulus penetration assay. *Molecular Reproduction and Development* **46**:392-400.
- Pillai, M.C., H. Blethrow, R.M. Higashi, C.A. Vines, and G.N. Cherr. 1997. Inhibition of the sea urchin sperm acrosome reaction by a lignin-derived macromolecule. *Aquatic Toxicology* **37**:139-156.
- Cherr, G.N., S.A. Meyers, A.I. Yudin, C.A. Vandevort, D.G. Myles, P. Primakoff, and J.W. Overstreet. 1996. The PH-20 protein in cynomolgus macaque spermatozoa: Identification of two different forms exhibiting hyaluronidase activity. *Developmental Biology* **175**:142-153.
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- Fan, T.W.-M., R.M. Higashi, G.N. Cherr, and M.C. Pillai. 1992. Use of noninvasive NMR spectroscopy and imaging for assessing produced water effects on mussel reproduction. Pp. 403-414 in: *Produced Water: Technological / Environmental Issues and Solutions*, J.P. Ray and F.R. Englehardt, eds. Plenum Press, New York.

JENIFER E. DUGAN

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Project:

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.
- Page, H.M., J.E. Dugan, D.S. Dugan, and J. Richards. 1999. Effects of an offshore oil platform on the distribution and abundance of commercially important crab species. *Mar. Ecol. Prog. Ser.* **185**:47-57.
- Dugan, J.E. and A. McLachlan. 1999. An assessment of longshore movement in *Donax serra*: Röding (Bivalvia: Donacidae) on an exposed sandy beach. *J. Exp. Mar. Bio. Ecol.* **234**:111-124.
- Barron, MG, T. Podrabsky, R.S. Ogle, J.E. Dugan, and others. 1999. Sensitivity of the sand crab *Emerita analoga* to a weathered oil. *Bull. Environmental Contamination & Toxicology* **62**:469-475.
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- Dugan, J.E. and G.E. Davis. 1993. Applications of fishery refugia to coastal fishery management. *Can. J. Fish. Aquat. Sci.* **50**:2029-2042.
- Dugan, J.E. and G.E. Davis. 1993. Introduction to the international symposium on fishery refugia. *Can. J. Fish. Aquat. Sci.* **50**:1991-1992.
- Wenner, A.M., J.E. Dugan, and D. Hubbard. 1993. Sand crab population biology on the California Islands and mainland. Pp. 335-348 in: *Third California Islands Symposium, Recent Advances in Research on the California Islands*, F.G. Hochberg, ed. Santa Barbara Museum of Natural History, CA.
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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.
- Hubbard, D.M. and J.E. Dugan. 1989. Northern occurrences of two estuarine crabs, the fiddler crab, *Uca crenulata* and the burrowing crab, *Malacoplax californiensis*. *Calif. Fish and Game* **75**:55-57.
- Wenner, A.M., Y.O. Richard, and J.E. Dugan. 1987. Hippid crab population structure and food availability on Pacific shorelines. *Bull. Mar. Sci.* **41**:221-233.

LINDA FERNANDEZ

Donald Bren School of Environmental Science and Management
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Project: *The Political Economy of the Rigs-to-Reef Option for Decommissioning of Offshore Oil and Gas Structures*

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|-------------------|-------|--|------|
| Education: | Ph.D. | Agricultural and Resource Economics, UC Berkeley | 1996 |
| | M.S. | Agricultural and Resource Economics, Univ. of Hawaii | 1989 |
| | B.S. | International Agricultural Development, UC Davis | 1985 |

Positions:

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| 1997-Present | Visiting Assistant Professor, School of Environmental Science and Management, UC Santa Barbara |
| 1996-1997 | Lecturer, School of Environmental Science and Management, UC Santa Barbara |
| 1993-1996 | Graduate Research Associate, Dept. of Agricultural and Resource Economics, UC Berkeley |
| 1987-1988 | Graduate Research Assistant, Water Resources Research Center and East-West Center, University of Hawaii, Honolulu. |

Professional Positions:

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| 1989-1993 | Environmental Scientist, U.S. Environmental Protection Agency, Region IX, Water Management Division, San Francisco. |
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Grants and Awards:

University of California Toxic Substances Program, Grant for 1998
Institute on Global Conflict and Cooperation, UC San Diego, Grant for 1997-1998
Institute of Industrial Relations, UC Berkeley, Grant for 1995-1996
College of Natural Resources, UC Berkeley, Grant for 1994-1995
U.S. Environmental Protection Agency, Region IX, Grant for 1993-1994
UC Berkeley Graduate Division Fellowship, 1991-1993

Selected Publications:

Fernandez, L and L Karp. 1998. Restoring wetlands through wetlands mitigation banks. *Environmental and Resource Economics* **12**:323-344.

Fernandez, L. 1997. Estimation of wastewater treatment objectives through maximum entropy. *Journal of Environmental Economics and Management* **32**:293-308.

Fernandez, L. 1997. An application of entropy estimation to public wastewater management. *Advances in Econometrics* Vol. 12.

Fernandez, L and D. Zilberman. 1997. Trade Liberalization and the Environment in the Pacific Basin: Coordinated Approaches to Trade and Environmental Policy. Economic Development and Cooperation in the Pacific Basin: Trade, Investment, and Environmental Issues, H. Lee and D. Roland-Holst, eds. Cambridge University Press, New York.

Fernandez, L. 1991. Demonstration of pesticide best management practices for controlling nonpoint source pollution in the monterey bay watershed. Proceedings from the Seventh Symposium on Coastal and Ocean Management. Long Beach, CA.

Fernandez, L. 1991. Environmental and economic feasibility of water supply alternatives in Hawaii and California-desalination, water marketing, and conservation. Proceeding from the Seventh Symposium on Coastal and Ocean Management. Long Beach, CA.

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Project: *Effects of Biologically Degraded Oil on Marine Invertebrate and Vertebrate Embryos and Larvae*

Education: B.S. Agricultural Business Management, University of California, Davis 1970
B.A., M.A. Biology, Sonoma State University 1981
Ph.D. Zoology, University of California, Davis 1987

Positions: 1996-present Lecturer, Division of Biological Sciences, University of California, Davis
1994-present Assistant Research Biologist II, University of California, Davis
1986-1994 Staff Research Associate, University of California, Davis, Bodega Marine Laboratory
1981-1985 Research Assistant/Teaching Assistant, University of California, Davis

Selected Publications:

- Baldwin, J.B., F.J. Griffin, and W.H. Clark, Jr. 1999. Immunological characterization of the acrosomal filament in the marine shrimp *Sicyonia ingentis*. *Zygote* **6**:329-339.
- Griffin, F.J., J.D. Baldwin, T.-I. Chen, and W.H. Clark, Jr. 1999. The composition and functions of the sperm acrosome reaction in Penaeoidean shrimp. *J. Reprod. Dev.* **44**:8.
- Griffin, F.J., M.C. Pillai, C.A. Vines, J. Kääriä, T. Hibbard-Robbins, R. Yanagimachi, and G.N. Cherr. 1998. Effects of salinity on sperm motility fertilization, and development in the Pacific herring, *Clupea pallasii*. *Biol. Bull.* **194**:25-35.
- Wang, S.W., F.J. Griffin, and W.H. Clark. 1997. Cell-cell association directed mitotic spindle orientation in the early development of the marine shrimp *Sicyonia ingentis*. *Development* **124**:773-780.
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- Clark, W.H., Jr., F.J. Griffin, and A.H. Wikramanayake. 1994. Pre-fusion events of sperm-oocyte interactions in the marine shrimp, *Sicyonia ingentis*. *Sem. Dev. Biol.* **5**:225-231.
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- Keller, R., F.J. Griffin, and W.H. Clark, Jr. 1991. *Gastrulation: Movements, Patterns and Molecules*, Bodega Marine Laboratory, Marine Sciences Series 3. Plenum Press, New York.
- Clark, W.H., Jr., T.I. Chen, M.C. Pillai, K. Uhlinger, J. Shoffner-Mcgee, and F.J. Griffin. 1991. The biology of gamete activation and fertilization in *Sicyonia ingentis* (Penaeoidea); present knowledge and future direction. *Bull. Inst. Zool., Academia Sinica* **16**:553-571.

- Pillai, M.C., F.J. Griffin, and W.H. Clark, Jr. 1990. Post spawning changes in the extracellular matrices in the eggs of *Sicyonia ingentis*. Pp. 201-207 in: *Advances in Invertebrate Reproduction*, M. Hoshi and O. Yamashita, eds. Vol. 5. Elsevier Science Publishers.
- Griffin, F.J. and W.H. Clark, Jr. 1990. Induction of acrosomal filament formation in the sperm of *Sicyonia ingentis*. *J. Exp. Zool.* **254**:296-304.
- Clark, W.H., Jr., A. Yudin, J.W. Lynn, F.J. Griffin, and M.C. Pillai. 1990. Jelly formation in penaeoidean shrimp eggs. *Biol. Bull.* **178**:295-299.
- Chen, T.I., F.J. Griffin, L. Crowe, and W.H. Clark, Jr. 1990. The anterior granule in the sperm of the shrimp *Sicyonia ingentis*. *J. Cell Biol.* 111, 113a.
- Pillai, M.C., F.J. Griffin, and W.H. Clark, Jr. 1989. Pre and post spawning alterations of the extracellular matrices in the eggs of *Sicyonia ingentis*. *Fifth International Congress of Invertebrate Reproduction*.

SCOTT HODGES

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Project: *Application of Genetic Techniques for use in Restoration of Surfgrass, Phyllospadix torreyi*

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

Positions: 1995 - present Assistant 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

Publications:

- Fulton, M. and SA Hodges. 1999. Floral isolation between *Aquilegia formosa* and *A. pubescens*. (Submitted, Proceedings of the Royal Society of London, Series B.).
- Bushakra, JM, SA Hodges, JB Cooper and DD Kaska. 1999. The extent of clonality and genetic diversity in the Santa Cruz Island Ironwood *Lyonothamnus floribundus*. *Molecular Ecology* **8**:471-476 (cover photo).
- Baker, HG, I. Baker, and SA 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. Floral nectar spurs and diversification. *International Journal of Plant Sciences* **158**:S81-S88.
- 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.
- Emms, SK, SA Hodges, and ML Arnold. 1996. Pollen-tube competition, siring success and consistent asymmetric hybridization in the Louisiana irises. *Evolution* **50**:2201-2206.
- Hodges, SA, J Burke and ML Arnold. 1996. Natural formation of iris hybrids: experimental evidence on the establishment of hybrid zones. *Evolution* **47**:2504-2509
- Carney, SE, SA Hodges and ML Arnold. 1996. Effects of differential pollen-tube growth on hybridization in the Louisiana irises. *Evolution* **47**:1432-1445.
- Hodges, SA and ML 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.

- Arnold, ML and SA Hodges. 1995. The fitness of Hybrids - A response to Day and Schluter. *Trends in Ecology and Evolution* **10**: 289.
- Arnold, ML and SA Hodges. 1995. Are natural hybrids fit or unfit relative to their parents? *Trends in Ecology and Evolution* **10**:67-70.
- Hodges, SA 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, SA and ML Arnold 1994. Columbines: a geographically wide-spread species flock. *Proceedings of the National Academy of Sciences, USA* **91**:5129-5132.
- Hodges, SA and ML Arnold. 1994. Floral and ecological isolation between *Aquilegia formosa* and *A. pubescens*. *Proceedings of the National Academy of Sciences, USA* **91**:2493-2496.
- Hodges, SA 1993. Consistent interplant variation in nectar characteristics of *Mirabilis multiflora*. *Ecology* **74**:542-548.
- Hodges, SA 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.

SALLY J. HOLBROOK

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Project: *Detecting Ecological Impacts: Effects of Taxonomic Aggregation in the Before-After/Control-Impact Paired Series Design*

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

Positions: 1987-present Professor, Department of Biological Sciences, 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:

- Schmitt, R.J. and S.J. Holbrook. Habitat-limited recruitment of coral reef damselfish. Submitted manuscript.
- Holbrook, S.J., Reed, D.C., Hansen, K. and Blanchette, C.A. Spatial and temporal patterns of predation on seeds of surfgrass, *Phyllospadix torreyi*. Submitted manuscript.
- Holbrook, S.J., Forrester, G.E. and R.J. Schmitt. 1999. Spatial patterns in abundance of a damselfish reflect availability of suitable habitat. *Oecologia*, In press.
- Schmitt, R.J., S.J. Holbrook 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.
- 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.
- 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. Mortality of juvenile damselfish: implications for assessing processes that determine abundance. *Ecology* 80:35-50.
- 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. Pp. 537-551 in Proc. 5th Indo-Pacific Fish Conf., Noumea, 1997. B Seret and J-Y Sire, eds. Paris: Soc. Fr. Ichtyol.
- Holbrook, S.J. and R.J. Schmitt. 1999. *In Situ* Nocturnal Observations of Reef Fishes Using Infrared Video. Pp. 805-812 in Proc. 5th Indo-Pacific Fish Conf., Noumea, 1997. B Seret and J-Y Sire, eds. Paris: Soc. Fr. Ichtyol.
- Schmitt, R.J. and S.J. Holbrook. 1999. Mortality of juvenile damselfish: implications for assessing processes that determine abundance. *Ecology* 80:35-50.
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- Reed, D.C., S.J. Holbrook, E. Solomon, 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. 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. Reseratis and J. Bernado eds. Oxford University Press.
- Holbrook, S.J. and R.J. Schmitt. 1997. Settlement patterns and process in a coral reef damselfish. *8th International Coral Reef Symposium*.**2**:1143-1148.
- Holbrook, S.J., R.J. Schmitt, and J.A. Stephens Jr. 1997. Changes in an assemblage of temperate reef fishes associated with a climate shift. *Ecological Applications* **7**:1299-1310.
- Holbrook, S.J. and R.J. Schmitt. 1996. On the dynamics and structure of reef fish communities: are resources tracked? Pp. 1948 in: *Long-term Studies of Vertebrate Communities*, M.L. Cody and J. A. Smallwood eds. Academic Press, NY.
- Osenberg, C.W., R.J. Schmitt, S.J. Holbrook, K.E. Abu-Saba, and A.R. Flegal. 1996. Detection of environmental impacts: natural variability, effect size, and power analysis. Pp. 83-108 in: *Detecting Ecological Impacts: Concepts and Applications in Coastal Habitats*, R.J. Schmitt and C.W. Osenberg, eds. Academic Press, San Diego, CA. [Republication of Osenberg *et al.* 1994, *Ecological Applications* **4**:16-30.]
- Schmitt, R.J. and S.J. Holbrook. 1996. Fine-scale patterns of larval settlement in a planktivorous damselfish - do they predict recruitment? *Australian Journal of Marine and Freshwater Research* **47**:449-463.
- Steichen, D.J. Jr., S.J. Holbrook, and C.W. Osenberg. 1996. The response of benthic and demersal macrofauna to organic enrichment at a natural oil seep. *Marine Ecology Progress Series* **138**:71-82.
- Holbrook, S.J., M.J. Kingsford, R.J. Schmitt, and J.S. Stephens, Jr. 1995. Spatial and temporal patterns in assemblages of temperate reef fish. *Amer. Zoologist* **34**:463-475.
- Holbrook, S.J. and R.J. Schmitt. 1995. Compensation in resource use by foragers released from interspecific competition. *J. Exp. Mar. Biol. Ecol.* **185**:219-233.
- Osenberg, C.W., R.J. Schmitt, S.J. Holbrook, K.E. Abu-Saba, and A.R. Flegal. 1994. Detection of environmental impacts: power analysis and spatial inference. *Ecological Applications* **4**:16-30.
- Holbrook, S.J. 1993. The effect of food density and dispersion on patch selection by foraging black surfperch. Pp. 485-493 in: *Third California Islands Symposium: Recent Advances in Research on the California Islands*, F.G. Hochberg, ed. Santa Barbara Museum of Natural History, CA.
- Holbrook, S.J., S.L. Swarbrick, R.J. Schmitt, and R.F. Ambrose. 1993. Reef architecture and reef fish: Correlates of population densities with attributes of subtidal rocky environments. Pp. 99-106 in: *Proceedings of the Second International Temperate Reef Ecology Symposium*, Battershill, C.N., D.R. Schiel, G.P. Jones, R.G. Creese, and A.B. MacDiamid eds. National Institute of Water and Atmospheric Research, New Zealand Oceanographic Institute.
- Holbrook, S.J. 1992. Review of "*Ecology of Coral Reef Fish*" by P.F. Sale. *Ecology* **73**:1934-1935.
- Holbrook, S.J. and R.J. Schmitt. 1992. Causes and consequences of dietary specialization in surfperches: patch choice and intraspecific competition. *Ecology* **73**:402-412.

- Osenberg, C.W., S.J. Holbrook, and R.J. Schmitt. 1992. Implications for the design of environmental assessment studies. Pp. 75-89 in: *Perspectives in the Marine Environment: Proceedings from a Symposium on the Marine Environment of Southern California*, S. Yoder and P.M. Griffman, eds. USC Sea Grant, Los Angeles, CA.
- Osenberg, C.W., R.J. Schmitt, and S.J. Holbrook. 1992. Spatial scale of ecological effects associated with an open coast discharge of produced water. Pp. 387-402 in: *Produced Water: Technological/Environmental Issues and Solutions*, J. Ray and F.R. Engelhardt, eds. Plenum Press, New York.
- Holbrook, S.J., M.H. Carr, R.J. Schmitt, and J.A. Coyer. 1990. The effect of giant kelp on local abundance of demersal fishes: the importance of ontogenetic resource requirements. *Bulletin of Marine Science* **47**: 104-114.
- Holbrook, S.J., R.J. Schmitt, and R.F. Ambrose. 1990. Biogenic habitat structure and characteristics of temperate reef fish assemblages. *Australian Journal of Ecology* **15**: 489-503.
- Schmitt, R.J. and S.J. Holbrook. 1990. Contrasting effects of giant kelp on dynamics of surfperch populations. *Oecologia* **84**:419-429.
- Schmitt, R.J. and S.J. Holbrook. 1990. Population responses of surfperch released from competition. *Ecology* **71**:1653-1665.

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Project: *The Political Economy of the Rigs-to-Reef Option for Decommissioning of Offshore Oil and Gas Structures*

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: 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
1991 Technical Consultant, Santa Barbara County Energy Division
1990 Lecturer, Department of Political Science, University of California, Santa Barbara

Selected Publications:

McGinnis, M.V., J. Woolley, and J. Gamman. 1999. Bioregional conflict resolution: Rebuilding community in watershed planning and organizing. *Environmental Management* **24**:1-12.

McGinnis, M.V. 1998. *Bioregionalism: The Tug and Pull of Place*. London and New York: Routledge.

McGinnis, M.V. 1997. An analysis of the role of ecological science in offshore continental shelf abandonment policy. In: *Proceedings of California and the World Ocean '97*, Organized and sponsored by Coastal Zone Foundation and Resources Agency of California. 9 pp.

McGinnis, M.V. 1996. Perceptions and restoration ecology: A comparison of restoration discourses. *Inquiry: An Interdisciplinary Journal of Philosophy*.

McGinnis, M.V. 1996. Deep ecology and the foundations of restorations. *Inquiry: An Interdisciplinary Journal of Philosophy* **39**:203-217.

McGinnis, M.V. 1995. Bioregional organization: A constitution of home place. *Human Ecology Review* **2**:72-84.

McGinnis, M.V. 1995. On the verge of collapse: The Columbia River system, wild salmon and the Northwest Power Planning Council. *Natural Resources Journal* **35**:520-552.

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

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

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

- McGinnis, M.V. 1993. Low-level radioactive waste compacts: Cases in the illogic of collective action. In: *Problems and Prospects for Nuclear Waste Disposal Policy*, E.B. Herzik and A. Mushkatel, eds. Greenwood Press, CT.
- McGinnis, M.V. and J.T. Lima. 1993. California ocean use conflict management--An assessment of two integrating approaches. Pp. 705-722 in: *International Perspective on Coastal and Ocean Space Utilization*, P.M. Griffman and J. Fawcett, eds. University of Southern California Sea Grant, CA.
- McGinnis, M.V. and W. Cohan. 1992. Ecology and international studies. Pp. 245-267 in: *Revealing the World: An Interdisciplinary Reader in International Studies*, D Lieberman and M. Gurtow, eds. Kendall/Hunt Publ. Co.
- McGinnis, M.V. 1991. San Luis Obispo's measure A--check or checkmate? Pp. 119-119 in: *The California Coastal Zone Experience*, G.W. Domurat and T.H. Wakeman, eds. American Society of Civil Engineers, NY,
- 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.

STEVEN N. MURRAY

Department of Biological Science
California State University, Fullerton
Fullerton, CA

Project: *Evaluating the Impact of Oil Spills on Southern California Rocky Intertidal Populations and Communities: Development of a Handbook*

Education: B.A. University of California, Santa Barbara 1966
M.A. University of California, Santa Barbara 1968
Ph.D. University of California, Irvine 1971

Positions: 1971-present Assistant, Associate, Associate and Professor, Department of Biological Science, California State University, Fullerton
June 1996 Invited Instructor, NSF Chautaugua short Course, The Marine Life of Santa Catalina Island and its Surrounding Waters
Summer 1996 Invited Instructor, Friday Harbor Laboratories, University of Washington, Phycology Course
1985-93 Research Associate, University of California, Irvine
Summer 1990 Invited Instructor, Escuela de Ciencias Marinas, Universidad Autonoma Baja California Norte, Ensenada, Mexico
1983,1985 Invited Instructor for Marine Ecology course, Western Canadian Universities Consortium
Summer 1974 Invited Instructor for Marine Plant Life in the Sea, University of Hawaii, Manoa

Awards:

California State University, Fullerton:
1989-1990 A.J. Diefenderfer Dean's Award
1993-94 Student Health Professions Outstanding Professor Award
1994-95 Student Athletes Professor of the Year Award
1993-94 Student Service Awardee
1994-95;
1996-97 Distinguished Faculty Member, School of Natural Science and Mathematics
1994-95;
1997-98 Faculty Marshal; School of Natural Science and Mathematics
1995,96 Nominee, Outstanding Professor Award
1997 Performance Salary Step Increase (PPSI) program: Recipient, three-step merit pay increase for performance in scholarly and creative activity

Peer-reviewed Publications:

- Hall, J.D. and S. N. Murray. 1998. Environmental control of the life history of a Santa Catalina Island population of *Liagora californica* (Nemaliales, Rhodophyta) in the field and laboratory culture. *Phycologia* **37**:184-194.
- Wakefield, R.L. and S.N. Murray. 1998. Factors influencing food choice by the seaweed-eating marine snail *Norrisia norrisi* (Trochidae). *Marine Biology* **130**:631-642.
- Pearson, E. and S.N. Murray. 1997. Patterns of reproduction, generic diversity, and genetic differentiation in California populations of the geniculate corraline alga *Lithothrix aspergillum* (Rhodophyta). *Journal of Phycology* **33**:753-763.
- Murray, S.N. 1996. Peter D. Dixon, Prominent Phycologists of the 20th Century. Pp. 262-270 in: *Phycological Society of America Special Publication*, D. Garbary and M.J. Wynne, eds. Lancelot Press, Hantsport, Nova Scotia.

- Murray, S.N. and R. B. Bray . 1993. Benthic Macrophytes. Pp. 304-368 in: *Ecology of the Southern California Bight: A Synthesis and Interpretation*, M.D. Dailey, D.J. Reish, and J.W. Anderson, eds. University of California Press, Berkeley.
- Bokn, T.L., F.E. Moy, and S.N. Murray. 1993. Long-term effects of diesel oil on rocky shore communities in mesocosms. II. Effects on selected populations. *Botanica Marina* **36**:313-319.
- Bokn, T.L., F.E. Moy, J.B. Magnusson, and S.N. Murray. 1992. Changes in fucoid distributions and abundances in the Inner Oslofjord, Norway: 1987-80 vs. 1988-90. *Acta Phytogeographica Suecica* **78**:117-124.
- Murray, S.N., P.S. Dixon. 1992. The Thodophyta: some aspects of their biology. III. *Oceanography Marine Biology, Annual Review* **30**:1-148.
- Littler, M.M., Littler, D.S., R.R. Seapy, and S.N. Murray. 1991. Southern California rocky intertidal ecosystems. Pp. 272-296 in: *Ecosystems of the world*, Volume 24: Intertidal and Littoral Ecosystems, A.C. Mathieson and P. Nienhuis eds. Elsevier Science Publishers, Amsterdam.
- Horn, M.M., M.B. Fris, C.D. Irelan, and S.N. Murray. 1990. Diurnal feeding periodicity of an herbivorous blenniid fish, *Parablennius sanguinolentus* (Pallas). Pp. 170-182 in the western Mediterranean. *Proceedings of the 24th European Marine Biology Symposium Trophic Relationships in the Marine Environment*.
- S.N. Murray and M.M. Littler. 1989. Seaweeds and seagrasses of southern California: checklists for twenty-one rocky intertidal sites. *Bulletin of the Southern California Academy of Sciences*, **88**:61-79.
- S.N. Murray and M.H. Horn. 1989. Variations in standing stocks of central California macrophytes from a rocky intertidal habitat before and during the 19 82-83 El Niño. *Marine Ecology Progress Series* **58**:113-122.
- S.N. Murray and M.H. Horn. 1989. Seasonal dynamics of macrophyte populations from an eastern North Pacific rocky intertidal habitat. *Botanica Marina* **32**:457-473.
- Brophy, T.C. and S.N. Murray. 1989. Field and laboratory culture studies of a population of *Endarachne binghamiae* (Phaeophyta) from southern California. *Journal of Phycology* **25**:6-15.

CRAIG W. OSENBURG

Department of Zoology
University of Florida
Gainesville, FL

Project: *Detecting Ecological Impacts: Effects of Taxonomic Aggregation in the Before-After/Control-Impact Paired Series Design*

Education: B.A. Biology, University of California, Santa Barbara (*summa cum laude*) 1980
Ph.D. Ecology, Michigan State University 1988

Positions: 1998-present Associate Professor, Department of Zoology, University of Florida
1995-1998 Assistant Professor, Department of Zoology, University of Florida
1991-1995 Assistant Professor, Department of Integrative Biology, University of California, Berkeley (on leave without pay, 1991-92, 1995-96)
1989-1996 Assistant Research Biologist, Marine Science Institute, University of California, Santa Barbara
1988-1993 Research Associate, Kellogg Biological Station, Michigan State University
1988-1992 Lecturer, Department of Biological Sciences, University of California, Santa Barbara
1988-1991 Post-graduate Research Biologist, Marine Science Institute, University of California, Santa Barbara

Distinctions: 1987 Kellogg Biological Station Scholarship Award
1985-1986 MSU College of Natural Sciences Fellowship
1982-1985 National Science Foundation Predoctoral Fellowship

Research Interests:

Size and stage-structured interactions, and their implications for population dynamics and community patterns. The roles of predation and food limitation in aquatic ecosystems. Quantification of effect size (and interaction strength) and its variation among organisms and environments. The design and implementation of whole ecosystem experiments and environmental assessment studies.

Selected Publications:

Wilson, W.G. C.W. Osenberg, R.J. Schmitt and R. Nisbet. 1999. Complementary foraging behavior allows coexistence of two grazers. *Ecology* In press.

Schmitt, R.J., S.J. Holbrook, 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.

Osenberg, C.W., O. Sarnelle, D.E. Goldberg. 1999. Meta-analysis in ecology: concepts, statistics, and applications. *Ecology* 80:1103-1104.

Downing, J., C.W. Osenberg, and O. Sarnelle. 1999. Meta-analysis of marine nutrient-enrichment experiments: variation in the magnitude of nutrient limitation. *Ecology* 80:1157-1167.

Osenberg, C.W., O. Sarnelle, S.D. Cooper, and R.D. Holt. 1999. Resolving ecological questions through meta-analysis: goals, metrics and models. *Ecology* 80:1105-1117.

Mittelbach, G.G., C.W. Osenberg, and P. Wainwright. 1999. Variation in feeding morphology between pumpkinseed populations: phenotypic plasticity or evolution? *Evolutionary Ecology Research* 1:111-128.

- Osenberg, C.W. and C.M. St Mary. 1998. Meta-analysis: synthesis or statistical subjugation? *Integrative Biology: Issues, News and Reviews* **1**:37-41. (Invited and reviewed by editor)
- Moeller, R.E., R.G. Wetzel, C.W. Osenberg. 1998. Concordance of phosphorus limitation in lakes: Bacterioplankton, phytoplankton, epiphyte-snail consumers, and rooted macrophytes. Pp. 318-325 in: *The Structuring Role of Submersed Macrophytes in Lakes*, E. Jeppesen, M. Søndergaard, M. D Søndergaard, and K. Christoffersen eds. Springer-Verlag, Berlin.
- Osenberg, C.W., O. Sarnelle, and S.D. Cooper. 1997. Effect size in ecological experiments: in the application of biological models in meta-analysis. *American Naturalist* **15**:798-812.
- Steichen, D.J., Jr., S.J. Holbrook, and C.W. Osenberg. 1996. The response of benthic and demersal macrofauna to organic enrichment at a natural oil seep. *Marine Ecology Progress Series* **138**:71-82.
- Ambrose, R.F., R.J. Schmitt, and C.W. Osenberg. 1996. Predicted and observed environmental impacts: can we foretell ecological change? Pp. 343-367 in: *Detecting Ecological Impacts: Concepts and Applications in Coastal Habitats*, R.J. Schmitt and C.W. Osenberg, eds. Academic Press, San Diego, CA.
- Osenberg, C.W. and R.J. Schmitt. 1996. Detecting ecological impacts caused by human activities. Pp. 3-17 in: *Detecting Ecological Impacts: Concepts and Applications in Coastal Habitats*, R.J. Schmitt and C.W. Osenberg, eds. Academic Press, San Diego, CA.
- Osenberg, C.W., R.J. Schmitt, S.J. Holbrook, K.E. Abu-Saba, and A.R. Flegal. 1996. Detection of environmental impacts: natural variability, effect size, and power analysis. Pp. 83-108 in: *Detecting Ecological Impacts: Concepts and Applications in Coastal Habitats*, R.J. Schmitt and C.W. Osenberg, eds. Academic Press, San Diego, CA. [Republication of Osenberg *et al.* 1994, *Ecological Applications* **4**:16-30.]
- Schmitt, R.J. and C.W. Osenberg (editors and contributing authors). 1996. *Detecting Ecological Impacts: Concepts and Applications in Coastal Marine Habitats*. Academic Press, San Diego, CA. 401p.
- Schmitt, R.J., C.W. Osenberg, W.J. Douros, and J. Chesson. 1996. The art and science of administrative environmental impact assessment. Pp. 279-291 in: *Detecting Ecological Impacts: Concepts and Applications in Coastal Habitats*, R.J. Schmitt and C.W. Osenberg, eds. Academic Press, San Diego, CA.
- Mittelbach, G.G., A.M. Turner, D.J. Hall, J.E. Rettig, and C.W. Osenberg. 1995. Perturbation and resilience: a long-term whole-lake study of predator extinction and reintroduction. *Ecology* **76**:2347-2360.
- Olson, M.H., G.G. Mittelbach, and C.W. Osenberg. 1995. Competition between predator and prey: resource-based mechanisms and implications for stage-structured populations. *Ecology* **76**:1758-1771.
- Osenberg, C.W. and G.G. Mittelbach. 1995. The relative importance of resource limitation and predator limitation in food webs. In: *Food Webs: Dynamics and Structure*, G. Polis and K. Winemiller, eds. Chapman and Hall, NY.
- Osenberg, C.W., R.J. Schmitt, S.J. Holbrook, K.E. Abu-Saba, and A.R. Flegal. 1994. Detection of environmental impacts: natural variability, effect size, and power analysis. *Ecological Applications* **4**:16-30.
- Osenberg, C.W. and R.J. Schmitt. 1994. Detecting human impacts in marine habitats. *Ecological Applications* **4**:1-2.
- Osenberg, C.W., R.J. Schmitt, S.J. Holbrook, and D. Canestro. 1992. Spatial scale of ecological effects associated with an open coast discharge of produced water. Pp. 387-402 in: *Produced Water: Technological/Environmental Issues and Solutions*, J. Ray and F.R. Engelhardt, eds. Plenum Press, NY.

H. MARK PAGE

Marine Science Institute
University of California
Santa Barbara, CA

Project: *Early Development of Fouling Communities on Offshore Oil Platforms*

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:

- Galindo-Bect, M. S., E. P. Glenn, H. M. Page, L. A. Galindo-Bect, J. M. Hernandez-Ayon, R. L. Petty, and J. Garcia-Hernandez. Analysis of penaeid shrimp landings in the northern Gulf of California in relation to Colorado River discharge. *Fishery Bulletin*, in press
- Page, H.M., J. E. Dugan, D. Dugan, 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.
- Page, H.M. Variation in the natural abundance of ¹⁵N 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., R.L. Petty, 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.
- Dugan, J.E., D.M. Hubbard, 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., J.E. Dugan, 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., A. Fiala-Medioni, C.R. Fisher, 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., C.R. Fisher, 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.

CAROLYN POMEROY

Institute of Marine Science
University of California
Santa Cruz, CA

Project: *The Political Economy of the Rigs-to-Reef Option for Decommissioning of Offshore Oil and Gas Structures*

Education: B.A. Yale University, Southeast Asian Studies 1985
M.A. University of Miami, Rosenstiel School of Marine and Atmospheric Science Marine Affairs 1989
Ph.D. Texas A&M University, Wildlife & Fisheries Sciences 1993

Positions: 1995-present Assistant Research Scientist, Institute of Marine Sciences, UCSC
1998-present Lecturer, Ocean Sciences Board, UCSC
1995-96 Lecturer, California State University, Monterey Bay
1993-95 Visiting Scientist, Workshop in Political Theory & Policy Analysis, Indiana University
1994 Lecturer, School of Public and Environmental Affairs, Indiana University

Research experience and interests:

Local institutions for common pool resource management; cooperative management of local fisheries; territorial use rights in fisheries (Big Sur, CA; Lake Chapala, Mexico; Quintana Roo, Mexico; Skagit System Cooperative, Washington)

Social identity and cooperation in the commons (Lake Chapala, Mexico; Skagit System Cooperative, Washington)

Marine resource conflicts and conflict resolution (Lake Chapala, Mexico; Quintana Roo, Mexico; Santa Barbara Channel, CA; Skagit System Cooperative, Washington; Southeast Asian artisanal fisheries)

Social and economic organization of fisheries; social and economic impact assessment, for fishery management, mitigation of fish contamination, and offshore oil platform decommissioning (California market squid; Mare Island Naval Shipyard and Vallejo, CA; Santa Barbara Channel, CA)

Management of coastal and marine protected areas (Miami, FL; Half Moon Caye, Belize; Big Creek, CA, coastal CA)

Honors and awards:

1997 Most Innovative Poster, Sanctuary Currents '97, Santa Cruz, CA
1994 Grant-in-Aid, Research and the University Graduate School, Indiana University
1993 Travel Research Grant, Workshop in Political Theory & Policy Analysis, Indiana University Graduate Program, Texas A&M University Enhancement Fund Grant
1992 Exploration Fund Grant-in-Aid, Explorers Club
F.T. Griswold Scholarship, Pan American Round Tables of Texas
1991 SEASPACE Scholarship, Houston Underwater Club
Grant-in-Aid of Research, Sigma Xi
1990-91 Gamma Sigma Delta, Agriculture Honor Society
1989 International Enhancement Grant, Texas A&M University
Regent's Fellowship, Texas A&M University

1987 Rosenstiel Fellowship, University of Miami

Selected Publications:

- Pomeroy, C. in press. Social considerations for marine resource management: Evidence from Big Creek Ecological Reserve. *California Cooperative Oceanic Fisheries Investigations Reports* 40.
- Pomeroy, C. and J. Beck. in press. An experiment in fisheries co-management: Preliminary evidence from Big Creek. *Society and Natural Resources*.
- Pomeroy, C. and M. FitzSimmons. 1998. Information needs for effective management of the California market squid fishery: The role of social science research. *California Cooperative Oceanic Fisheries Investigations Reports* 39:108-114.
- Bailey, C., and C. Pomeroy. 1996. Resource dependency and community stability in coastal fishing communities of Southeast Asia. *Society and Natural Resources* 9:191-199.
- Pomeroy, C. 1995. Review of *Ecological Identity* by Mitchell Thomashow. *Journal of Political Ecology* 2:47-51.
- Pomeroy, C. 1994. Obstacles to institutional development in the fishery of Lake Chapala, Mexico. Pp.17-41 in *Folk Management in the World's Fisheries*, C.L. Dyer and J.R. McGoodwin, eds. Niwot, CO: University Press of Colorado.

PETER T. RAIMONDI

Department of Biology
University of California
Santa Cruz, CA

Projects: *Effects of an Oil Spill on Multispecies Interactions that Structure Intertidal Communities*
Inventory of Rocky Intertidal Resources in 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
1981-82 Dean's Award for Academic Excellence, University of Arizona
1984 Sigma Xi Grant-in-Aid of Research
1986 University of California Patent Fund
1987-88 Office of Naval Research Postdoctoral Fellowship
1988-89 University of Melbourne Research Fellowship
1989-91 Australian Research Council Fellowship

Selected Publications:

Carr MH, and PT Raimondi. 1999. Marine protected areas as a precautionary approach to management. CALCOFI reports.

Reed DC, MH Carr, L Goldwasser and PT Raimondi. Role of dispersal potential in determining the spatial structure of an assemblage of sedentary marine organisms. *Ecology*. In press.

Carr MH and PT Raimondi. Concepts relevant to the design and evaluation of harvest reserves. Proceedings of workshop on rockfish refugia.

Raimondi PT and S Forde. Processes structuring communities: evidence for trait mediated interactions through induced polymorphisms. *Ecology*. In press.

Raimondi PT and ANC Morse. Complex larval behavior and the vertical distribution and orientation of *Agaricia humilis* (Scleractinia). *Ecology*.

Raimondi, P.T., A.M. Barnett, and P.R. Krause. 1997. The effects of drilling muds on marine invertebrate larvae and adults. *Environmental Toxicology and Chemistry* **16**:1218-1228.

- Allstatt, J.A., R.F. Ambrose, J.M. Engle, P.L. Haaker, K.D. Lafferty, 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 Habitats*, 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., A. Morse, N. Hooker, and P.T. Raimondi. 1994. Morphogen-based chemical flypaper for *Agarcia humilis* larvae. *Biological Bulletin* **186**:172-181.
- Lively, C.M., P.T. Raimondi, and L.F. Delph. 1993. Intertidal community structure: space-time interactions in the Northern Gulf of California. *Ecology* **74**:162-173.
- 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.
- Raimondi, P.T. 1992. Adult plasticity and rapid larval evolution in a recently isolated barnacle population. *Biological Bulletin* **182**:210-220.
- 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. 1991 The settlement of *Chthamalus anisopoma* largely determines its adult distribution. *Oecologia* **85**:349-360.
- 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.
- Raimondi, P.T. 1990. Patterns, mechanisms, and consequences of variability in settlement and recruitment in an intertidal barnacle. *Ecological Monographs* **60**:283-309.
- Raimondi, P.T. and M.J. Keough. 1990. Behavioural 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.

DANIEL C. REED

Marine Science Institute
University of California
Santa Barbara, CA

Project: *Application of Genetic Techniques for use in Restoration of Surfgrass (Phyllospadix torreyi)*

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: 1994-present Associate Research Biologist, Marine Science Institute, University of California, Santa Barbara
1989-94 Assistant Research Biologist, Marine Science Institute, University of California, Santa Barbara
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:

- Holbrook, S.J., Reed, D.C., Hansen, K. and Blanchette, C.A. Spatial and temporal patterns of predation on seeds of surfgrass, *Phyllospadix torreyi*. Submitted manuscript.
- Reed, D.C., P.T. Raimondi, M.H. Carr and L. Goldwasser. The role of dispersal and disturbance in determining spatial heterogeneity in sedentary kelp-forest organisms. *Ecology*. In press.
- 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., M.A. Brzezinski, D.A. Coury, W.M. Graham, and R.L. Petty. 1999. Neutral lipids in macroalgal spores and their role in swimming. *Marine Biology* **133**:737-744
- Reed, D.C., S.J. Holbrook, E. Solomon, 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., T.W. Anderson, A.W. Ebeling, and M. Anghera. 1997. Role of reproductive synchrony in the colonization potential of kelp. *Ecology* **78**:2443-2457.
- Canestro, D. P.T. Raimondi, D.C. Reed, R.J. Schmitt, 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.
- Reed, D.C., A.W. Ebeling, T.W. Anderson, and M. Anghera. 1996. Differential reproductive responses to fluctuating resources in two seaweeds with different reproductive strategies. *Ecology* **77**:300-316.
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- Reed, D.C. 1990. An experimental evaluation of density dependence in a subtidal algal population. *Ecology* **71**:2286-2296.
- Reed, D.C. 1990. The effects of variable settlement and early competition on patterns of kelp recruitment. *Ecology* **71**:776-787.

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Department of History
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Project: *Public Policy, Oil Production, and Energy Consumption in Twentieth-Century, California*

Education: B.A. History and Studies in the Environment, Yale University 1992
M.A. U.S. History, University of California, Berkeley 1994
Ph.D. U.S. History, University of California, Berkeley, to be completed

Position: 1993-present Graduate Student Instructor, Reader, and Graduate Student Researcher,
University of California, Berkeley
1990 Council of Environmental Quality, Washington, D.C.
1988 Student Intern, U.S. Environmental Protection Agency, Boston, MA.

Awards and Honors:

1998-99 Mellon Foundation Dissertation Write-up Fellowship
1998 Historical Society of Southern California/Hayes Foundation Research Stipend
1997 W. Turrentine Jackson Prize
1996-98 Minerals Management Service, SCEI
1996-97 U.C. Energy Institute: California Energy Studies Program
1996-97 W.M. Keck and Fletcher Jones Foundation Fellowship
1992-93 Charles P. Howland Fellowship

Selected Publications:

Sabin, P. Searching for middle ground: native communities and oil extraction in the northern and central Ecuadorian Amazon, 1967-1993. *Environmental History*. Forthcoming.

Sabin, P. 1997. Home and abroad: The two "Wests" of Twentieth-Century United States History." *Pacific Historical Review* 46:305-335.

Sabin, P. 1995. High tide of equal protection: Justice Raymond L. Sullivan's opinions in Serrano and Westbrook, *The California Supreme Court Historical Society Yearbook* 2:133-157/17-48.

Sabin, P. 1995. Voices from the hydrocarbon frontier: Canada's Mackenzie Valley pipeline inquiry (1974-1977), *Environmental History Review* 19(1):17-48.

Book Reviews:

The Northwest Salmon Crisis: A Documentary History (1966), *Western Historical Quarterly* 28:95-96. J. Cone and S. Ridlington, eds.

Cultivating Crisis: The Human Cost of Pesticides in Latin America (1994), *Capitalism, Nature, Socialism* 6(4):127-29.

RUSSELL J. SCHMITT

Department of Ecology, Evolution and Marine Biology and
Coastal Research Center, Marine Science Institute
University of California
Santa Barbara, CA

- 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:

- Schmitt, R.J. and S.J. Holbrook. Habitat-limited recruitment of coral reef damselfish. Submitted manuscript.
- Holbrook, S.J., Forrester, G.E. and R.J. Schmitt. 1999. Spatial patterns in abundance of a damselfish reflect availability of suitable habitat. *Oecologia*, In press.
- Schmitt, R.J., S.J. Holbrook 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.
- 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. Mortality of juvenile damselfish: implications for assessing processes that determine abundance. *Ecology* **80**:35-50.
- 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. Pp. 537-551 in Proc. 5th Indo-Pacific Fish Conf., Noumea, 1997. B Seret and J-Y Sire, eds. Paris: Soc. Fr. Ichtyol.
- Holbrook, S.J. and R.J. Schmitt. 1999. *In Situ* Nocturnal Observations of Reef Fishes Using Infrared Video. Pp. 805-812 in Proc. 5th Indo-Pacific Fish Conf., Noumea, 1997. B Seret and J-Y Sire, eds. Paris: Soc. Fr. Ichtyol.

- 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.
- Holbrook, S.J., R.J. Schmitt, and J.A. Stephens Jr. 1997. Changes in an assemblage of temperate reef fishes associated with a climate shift. *Ecological Applications* 7:1299-1310.
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- Schmitt, R.J. 1996. Exploitation competition in mobile grazers - trade-offs in use of a limited resource. *Ecology* 77:408-425.
- Schmitt, R.J. and S.J. Holbrook. 1996. Fine-scale patterns of larval settlement in a planktivorous damselfish - do they predict recruitment? *Australian Journal of Marine and Freshwater Research* 47:449-463.
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- Osenberg, C.W. and Schmitt, R.J. 1996. Detecting ecological impacts caused by human activities. Pp. 3-16 in: *Detecting Ecological Impacts: Concepts and Applications in Coastal Habitats*, R.J. Schmitt and C.W. Osenberg, eds. Academic Press, San Diego, CA.
- Osenberg, C.W., R.J. Schmitt, S.J. Holbrook, K. E. Abu-Saba, and A. R. Flegal. 1996. Detection of environmental impacts: natural variability, effect size, and power analysis. Pp. 83-108 in: *Detecting Ecological Impacts: Concepts and Applications in Coastal Habitats*, R.J. Schmitt and C.W. Osenberg, eds. Academic Press, San Diego, CA. [Republication of Osenberg *et al.* 1994, *Ecological Applications* 4:16-30.]
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Osenberg, C.W. and R.J. Schmitt. 1994. Detecting human impacts in marine habitats. *Ecological Applications* 4:1-2.

STEPHEN SCHROETER

Marine Science Institute
University of California
Santa Barbara, CA

Project: *Adding Biology to BACI: Exploring the use of functional groups, trophic relationships, biological indices, and multiple ecologically similar comparison sites in choosing models and estimating effects in impact analysis*

Education: B.S. Zoology, Brigham Young University 1969
M.S. Zoology, Brigham Young University 1972
Ph.D. Ecology, University of California, Santa Barbara 1978

Positions: 1987-present Ecologist and Partner, Ecometrics
1987-present Reviewer for Ecology, Ecological Monographs, Journal of Ecology Marine Biology, Marine Ecology Progress Series, American Naturalist
1995-present Lecturer, University of California, San Diego Extension Program
1996-present Associate Research Biologist, Marine Science Institute, University of California, Santa Barbara
1989-present Adjunct Professor, Department of Biology, San Diego State University
1983-88 Research Assistant Professor and Principal Investigator, Department of Biological Sciences, University of Southern California, Los Angeles, CA
1978-83 Allan Hancock Fellow and Research Associate, Department of Biological Sciences, University of Southern California, Los Angeles, CA

Awards: 1988 Outstanding publication in the Marine Fisheries Review for 1985, with Susumu Kato
1985-87 Faculty Research Incentive Grants, University of Southern California
1982-88 Contracts with the Marine Review Committee, Inc. for studies of benthic and epiphytic invertebrates in kelp beds near the San Onofre Nuclear Generating Station.
1977-82 Contracts with the Marine Review Committee, Inc. for studies of benthic and epiphytic invertebrates in kelp beds near the San Onofre Nuclear Generating Station.
1976-77 Ford Foundation Fellowship
1975-76 Sea Grant Traineeship, University of California
1975 University Fellowship, University of California
1971 NSF Graduate Traineeship, Brigham Young University
1971 University Fellowship, Brigham Young University

Publications:

Bence, J.R., A. Stewart-Oaten, and S.C. Schroeter. 1996. Estimating the size of an effect from a Before-After-Control Impact-Pairs design: the predictive approach applied to a power plant study. Pp. 133-149 in: *Ecological Impacts Assessment: Conceptual Issues and Application in Coastal Marine Habitats*, R.J. Schmitt and C.W. Osenberg, eds. University of California Press, Berkeley, CA

Bernstein, B.B., S.C. Schroeter, and K.H. Mann. 1983. Sea urchin (*Strongylocentrotus droebachiensis*) aggregating behavior investigated by a subtidal multifactorial experiment. *Canadian Journal of Fisheries and Aquatic Sciences* **40**:1975-1986.

Cameron, R.A. and S.C. Schroeter. 1980. Sea urchin recruitment: effect of substrate selection on juvenile distribution. *Marine Ecology Progress Series* **2**:243-247.

- Dean, T.A., S.C. Schroeter, and J.D. Dixon. 1984. Effects of grazing by two species of sea urchins (*Strongylocentrotus franciscanus* and *Lytechinus anamesus*) on recruitment and survival of two species of kelp (*Macrocystis pyrifera* and *Pterygophora californica*). *Marine Biology* **78**:301-313.
- Dixon, J.D., S.C. Schroeter, and J. Kastendiek. 1981. Effects of the encrusting bryozoan, *Membranipora membranacea*, on the loss of blades and fronds by the giant kelp, *Macrocystis pyrifera* Laminariales). *Journal of Phycology* **17**:341-345.
- Ebert, T.A., S.C. Schroeter, and J.D. Dixon. 1993. Inferring demographic processes from size-frequency distribution. Effect of pulsed recruitment on simple models. *Fishery Bulletin* **91**:237-243.
- Ebert, T.A., S.C. Schroeter, J.D. Dixon, and P. Kalvass. 1994. Settlement patterns of red and purple sea urchins (*Strongylocentrotus franciscanus* and *S. purpuratus*) in California. *Marine Ecology Progress Series* **111**:41-52.
- Kato, S. and S.C. Schroeter. 1985. Biology of the red sea urchin, (*Strongylocentrotus franciscanus*) and its fishery in California. *Marine Fisheries Review* **47**:1-20.
- Kastendiek, J., S.C. Schroeter, and J.D. Dixon. 1981. The effect of seawater cooling system of a nuclear generating station on the growth of mussels in experimental populations. *Marine Pollution Bulletin* **12**:402-407.
- Lissner, A.L., G.L. Taghon, R.R. Diener, S.C. Schroeter, and J.D. Dixon. 1991. Review of recolonization and recovery of deep-water hard substrate communities. *Ecological Applications* **1**:258-267.
- Schroeter, S.C, J.D. Dixon, and J. Kastendiek. 1983. Effects of the starfish *Partifia miniata* on the distribution of the sea urchin *Lytechinus anamesus* in a southern California kelp forest. *Oecologia* **56**:141-147.

RACHEL A. SCHURMAN

Department of Sociology
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Project: *Public Policy, Oil Production, and Energy Consumption in Twentieth-Century California*

Education: B.A. Economics, University of Massachusetts 1979
M.A. Economics, Tufts University 1983
Ph.D. Sociology, University of Wisconsin 1993

Position: 1993-present Assistant Professor, Energy and Resources Group, and Department of Sociology, University of California, Berkeley
1990-91 Visiting Research Scholar, Institute of Economics, Austral University of Chile, Valdivia, Chile
1985-86 Research Analyst, Institute for Food and Development Policy, San Francisco, California
1980-84 Research Analyst, Center for Health Economics Research, Inc., Chestnut Hill, Massachusetts

Awards and Honors:

1996-97 University of California, Career Development Grant
1994 Third Annual Katherine Dupre Lumpkin Prize for best dissertation, Dept. of Sociology, University of Wisconsin-Madison
1993-94 Ciriacy-Wantrup Postdoctoral Fellowship in Natural Resource Economics, The Graduate Division, University of California
1992 Graduate School Fellowship Recipient, Dept of Sociology, University of Wisconsin-Madison
1990-91 U.S. Fulbright Program, Institute of International Education, Chile Program
1989-91 John D. and Catherine T. MacArthur Scholar, University of Wisconsin-Madison.

Research Interests:

Schurman spent five years working as a health economist at the Center for Health Economics Research in Boston, Massachusetts, where she published a number of articles in the health field. In 1984, she started a new career working on international development issues, and co-authored two books while at the Institute of Food and Development Policy, a San Francisco based "think tank" dedicated to food and hunger issues. Schurman's work is on natural resources and economic development particularly in Latin America.

Her interests include the political economy of natural resource industries; international fisheries issues; and environment and development in Chile. Schurman's newest project involves analyzing Japanese and Spanish strategies for gaining access to the fisheries resources of developing countries. In 1993, Schurman received the Ciriacy-Wantrup Post-Doctoral Fellowship in Natural Resource Economics at the University of California at Berkeley.

Selected Publications:

Schurman, R.A. 1997. The future of regional cooperation in a changing economic environment: the South Pacific Island countries in the 1990s. *Ocean Development and International Law* 28:369-403.
Schurman, R.A. 1997. Tuna dreams: Resource nationalism and the Pacific Islands tuna industry. *Development and Change* 29:107-136.
Schurman, R.A. 1996. Chile's new entrepreneurs and the "Economic Miracle": the invisible hand or a hand from the State? *Studies in Comparative International Development* 31:83-109.

Schurman, R.A. 1996. Snails, southern lake and sustainability - neoliberalism and natural resource exports in Chile. *World Development* **24**:1695-1709.

Barham, B., M. Clark, E. Katz and R.A. Schurman. 1992. Non traditional exports in Latin America: Towards an appraisal. *Latin American Research Review* **S92**:43-82.

Schurman, R.A. and B. Sheehan. 1992. Chiloé: An island wrestles with free market forces. North American Congress on Latin America. *Report on the Americas*.

Book Reviews:

Overfishing: Causes and consequences: A review of the ecologist's special issue. Capitalism, Nature, Socialism No. 25 (Spring 1996).

The bay shrimpers of Texas: Rural fishermen in a global economy, by R.L. Maril. *Contemporary Sociology - A Journal of Reviews* **25**:644-645.

ERIC R.A.N. SMITH

Department of Political Science
University of California
Santa Barbara, CA

Project: *A Design for a Time Series Study of a NIMBY Response*

| | | | |
|-------------------|-------|------------------------------------|------|
| Education: | A.B. | University of California, Berkeley | 1975 |
| | M.A. | University of California, Berkeley | 1976 |
| | Ph.D. | University of California, Berkeley | 1982 |

| | | |
|-------------------|--------------|---|
| Positions: | 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, E.R.A.N. How Political Activists See Offshore Oil Development: An In-depth Investigation of Attitudes on Energy Development. Final Study Report to the Minerals Management Service, U.S. Department of the Interior, July, 1998.

Smith, E.R.A.N. What is public opinion? *Critical Review*.

Smith, E.R.A.N. and S. Garcia. Californians' attitudes toward energy policy.

Smith, E.R.A.N. and S. Woodlief. Problems with the single peaked preference assumption in the spatial theory of elections.

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, 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: *The two majorities - the issue context of modern American politics*, B.E. Shafer and W.J.M. Claggett. *American Political Science Review* **90**:438-439.

Smith, E.R.A.N. 1996. Book Review: *The changing American mind - how and why American public opinion changed between 1960 and 1988*, 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*, B. Page and R. Shapiro. *Critical Review* **10**:95-105.

Smith, E.R.A.N. 1996. Book Review: *Public opinion in America - moods, cycles and swings*, J.A. Stimson. *Critical Review* **10**:95-105.

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., T. Epperlein 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., E.R.A.N Smith, J. Lindsay 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., R. Herrera and C.L. Herrera. 1992. Public opinion and congressional representation. *Public Opinion Quarterly* **56**:185-205.
- Smith, E.R.A.N., R. Herrera and C.L. Herrera. 1990. The measurement characteristics of congressional roll call indexes. *Legislative Studies Quarterly* **15**:283-295.
- Smith, E.R.A.N. and P. Squire. 1990. The effects of prestige names in question wording. *Public Opinion Quarterly* **54**:97-116.
- Smith, E.R.A.N. 1989. *The Unchanging American Voter*. The University of California Press, Berkeley, CA.
- Smith, E.R.A.N. and P. Squire. 1988. The effect of partisan information on voters in non-partisan election. *J. Politics* **50**:169-79.
- Smith, E.R.A.N. and P. Squire. 1987. State and National Politics in the Intermountain West. In: *The Politics of Realignment: Partisan Change in the Intermountain West*. Peter Galderisi *et al.*, eds. Westview Press, Boulder, CO.
- Smith, E.R.A.N. and P. Squire. 1987. Direct election of the president and the power of the states. *Western Political Quarterly* **40**:29-44.
- 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.
- Smith, E.R.A.N. 1981. "Reply." *American Political Science Review* **75**:152-55.
- Smith, E.R.A.N. 1980. The levels of conceptualization: False measures of ideological sophistication. *American Political Science Review* **74**:685-696.

ALLAN STEWART-OATEN

Department of Ecology, Evolution and Marine Biology
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Projects: *Environmental Assessment: Statistical Description of Variable Effects*
Adding Biology to BACI: Exploring the use of functional groups. Trophic relationships and multiple, ecologically similar comparison sites in choosing models and estimating effects impact analysis

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|-------------------|-------|--|------|
| Education: | B.A. | (Honours.: English & Pure Mathematics) | 1961 |
| | | Dip. Ed., University of Melbourne, Australia | 1962 |
| | M.S. | Mathematical Statistics, Michigan State University | 1967 |
| | Ph.D. | Mathematical Statistics, Michigan State University | 1969 |

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|-------------------|--------------|---|
| Positions: | 1976-present | Associate Professor of Mathematical Biology, Department of Biological Sciences, University of California, Santa Barbara |
| | 1975-present | Statistical Consultant to the Marine Review Committee |
| | 1978-1979 | Visiting Associate Professor of Zoology, University of Hawaii |
| | 1970-1976 | Assistant Professor of Mathematical Biology, Department of Biological Sciences, University of California, Santa Barbara |
| | 1969-1970 | Acting Assistant Professor of Statistics, Stanford University |

Selected Publications:

Goldberg, DE; Rajaniemi, T; Gurevitch, J; Stewart-Oaten, A. 1999. Empirical approaches to quantifying interaction intensity: Competition and facilitation along productivity gradients. *Ecology* **80**:1118-1131.

Bence, J.R., A. Stewart-Oaten, and S.C. Schroeter. 1996. Estimating the size of an effect from a Before-After-Control-Impact-Paired Series design: the predictive approach applied to a power plant study. Pp. 133-149 in: *Detection of Ecological Impacts: Conceptual Issues and Application in Coastal Marine Habitats*, R.J. Schmitt, and C.W. Osenberg, eds. Academic Press, San Diego, CA.

Nisbet, R.M., W.W. Murdoch, and A. Stewart-Oaten. 1996. Consequences for adult-fish stocks of human-induced mortality of immatures. Pp. 257-277 in: *Detection of Ecological Impacts: Conceptual Issues and Application in Coastal Marine Habitats*, R.J. Schmitt, and C.W. Osenberg, eds. Academic Press, San Diego, CA.

Stewart-Oaten, A. 1996. Goals in environmental monitoring. Pp. 17-27 in: *Detection of Ecological Impacts: Conceptual Issues and Application in Coastal Marine Habitats*, R.J. Schmitt, and C.W. Osenberg, eds. Academic Press, San Diego, CA.

Stewart-Oaten, A. 1996. Problems in the analysis of environmental monitoring data. Pp. 109-131 in: *Detection of Ecological Impacts: Conceptual Issues and Application in Coastal Marine Habitats*, R.J. Schmitt, and C.W. Osenberg, eds. Academic Press, San Diego, CA.

Stewart-Oaten, A. 1995. Rules and judgments in statistics - three examples. *Ecology* **76**:2001-2009.

Stewart-Oaten, A. , W.W. Murdoch, S.J. Walde. 1995. Estimation of temporal variability in populations. *American Naturalist* **146**:519-535.

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